ROM

Spring 2009 **$5** CAN

Magazine *of the* Royal Ontario Museum

volume 41:number 4
2009 spring

The Biodiversity Issue: THE PLIGHT OF THE RED KNOT: How a ROM scientist is working to preserve this endangered shorebird / Life in the Times of THE DEAD SEA SCROLLS / BARCODE OF LIFE: A short strand of DNA helps biologists rapidly identify living creatures / *Plus*: JAMES CHATTO on endangered fish / MARK KINGWELL out-thinks green technology

Display until June 12, 2009

03

0 74470 22669 7

rom.on.ca

J. E. H. MacDonald R.C.A.

"Mt. Goodsir from Odaray Bench, near Lake McArthur"
1925 | 21.6 x 26.6 cm | oil/board

Masters Gallery ltd.

107, 2115 – 4 Street SW, Calgary, AB T2S 1W8
Telephone 403.245.2064

www.mastersgalleryltd.com

Spring 2009
Volume 41, Number 4

p. 12

Learn why the Amerindian tribes of western Amazonia value an irate monkey frog

Contents

The Biodiversity Issue

Features

18 **The Plight of the Red Knot**
How biologists are tracking the progress of endangered migratory birds
BY ALLAN J. BAKER

24 **Barcoding Life**
Demystifying the project that aims to classify all life with a short strand of DNA
TEN ROM BIOLOGISTS REPORT

32 **Life in the Time of the Dead Sea Scrolls**
A glimpse of life and faith in Judea and Galilee 2,000 years ago
BASED ON A DESCRIPTION BY STEVEN SPENCER

Book of the Dead p.7

Front

3 First Word
6 What's On at the ROM
9 Opinion
10 Journal
13 Ask an Expert
14 Curator Profile
15 Map of Explorations
16 Green Space

Back

36 Shopping
37 Cuisine & Culture
38 Backyard Biodiversity
40 KidStuff!
48 Exhibit A

For Our Members

41 Members' Message
42 News and Programs
43 Events
44 Support
45 Travel
46 Sponsorship

ON THE COVER

Natural history: (main image) Shorebirds like the red knot are the most endangered migratory birds in the world.
Photo: Awei Lee

World cultures: The Wari culture of 600 to 1000 CE had a huge influence on material culture of its day in Peru.
Photo: Brian Boyle

INFORMATION

Royal Ontario Museum
100 Queen's Park
Toronto, ON M5S 2C6
Website: rom.on.ca
E-mail: info@rom.on.ca

HOURS
Saturday through Thursday: 10 am to 5:30 pm; Friday: 10 am to 9:30 pm; closed Christmas Day.

ROM LIBRARY
Public hours: Noon to 4:30 pm, Monday through Friday

ADMISSION PRICES
ROM Members: FREE*
Adults: $22
Students and seniors with ID: $19
Children (4 to 14 years): $15
Infants 3 and under: FREE

On Half-Price Friday Nights, presented by SunLife Financial, from 4:30 pm to 9:30 pm: Adults $11; students and seniors with ID $9.50; children $7.50

Admission, except for ticketed exhibitions, is free after 4:30 pm Wednesdays.

Admission is free on Tuesdays for post-secondary Canadian students with ID.

Museum and Arts Pass Program participant.

**All adult Members must present a valid membership card. Membership cards are not transferable.*

Photo: Monkey frog, Amy Lathrop

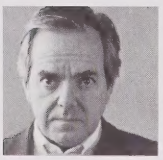
Our Contributors

Allan Baker
CURATOR

Baker ("The Plight of the Red Knot") has studied the evolution of birds since joining the ROM 36 years ago. With the introduction of increasingly complex technology, his group's research has compared bird species to see how they differ in morphology, proteins, DNA sequences, and genomes. One highlight was extracting DNA from extinct giant moas in New Zealand. Seeing the first DNA sequences from 4,000-year-old bones was awe-inspiring. For the last 15 years, Baker has worked on the conservation of shorebirds.

How do you live a green life? I minimize energy use in our house, don't use pesticides in the garden, and compost and recycle as much as possible.

What was your hairiest field moment? In southern Brazil, the Attorney General saw a TV program of our team catching red knots and taking blood for export to Canada for analysis. He ordered my arrest for allegedly violating non-export regulations on biological material. When the arresting officers arrived at the remote beach, we explained that we were actually part of a Brazilian government team!



James Chatto
WRITER

Chatto ("Cuisine & Culture") began writing about food while living in a remote Greek village in the early 1980s, farming olives and raising a family with his Canadian wife, Wendy Martin. Seven books later, he is still fascinated by the subject. *Toronto Life*'s restaurant columnist for 22 years, he also describes wine and spirits for the LCBO's *Food & Drink* magazine, while his work with Gold Medal Plates, fundraising for Olympic and Paralympic athletes, lets him see what the rest of Canada is cooking. Twice a year, he escapes from the table to edit *harry* magazine. An updated and illustrated 10th-anniversary edition of his book *The Man Who Ate Toronto* will be published this spring.

How do you live a green life? The biggest step my wife and I took was getting rid of our car. Chinatown is well served by public transport and we both love to walk. Renovating the house also gave us an opportunity to replace the old furnace, bathroom fixtures, and windows with energy-efficient alternatives.

Mark Kingwell
PHILOSOPHY PROFESSOR

Kingwell ("Opinion"), a professor of philosophy at the University of Toronto, is contributing editor of *Harper's Magazine*, and the former chair of the ROM's Institute for Contemporary Culture. He is the author of 12 books of political and cultural theory, has lectured internationally, and published articles on politics, art, architecture, and design. Kingwell has won National Magazine Awards, is the recipient of the Spitz Prize in political theory, and was awarded an honorary DFA from the Nova Scotia College of Art & Design for contributions to theory and criticism.

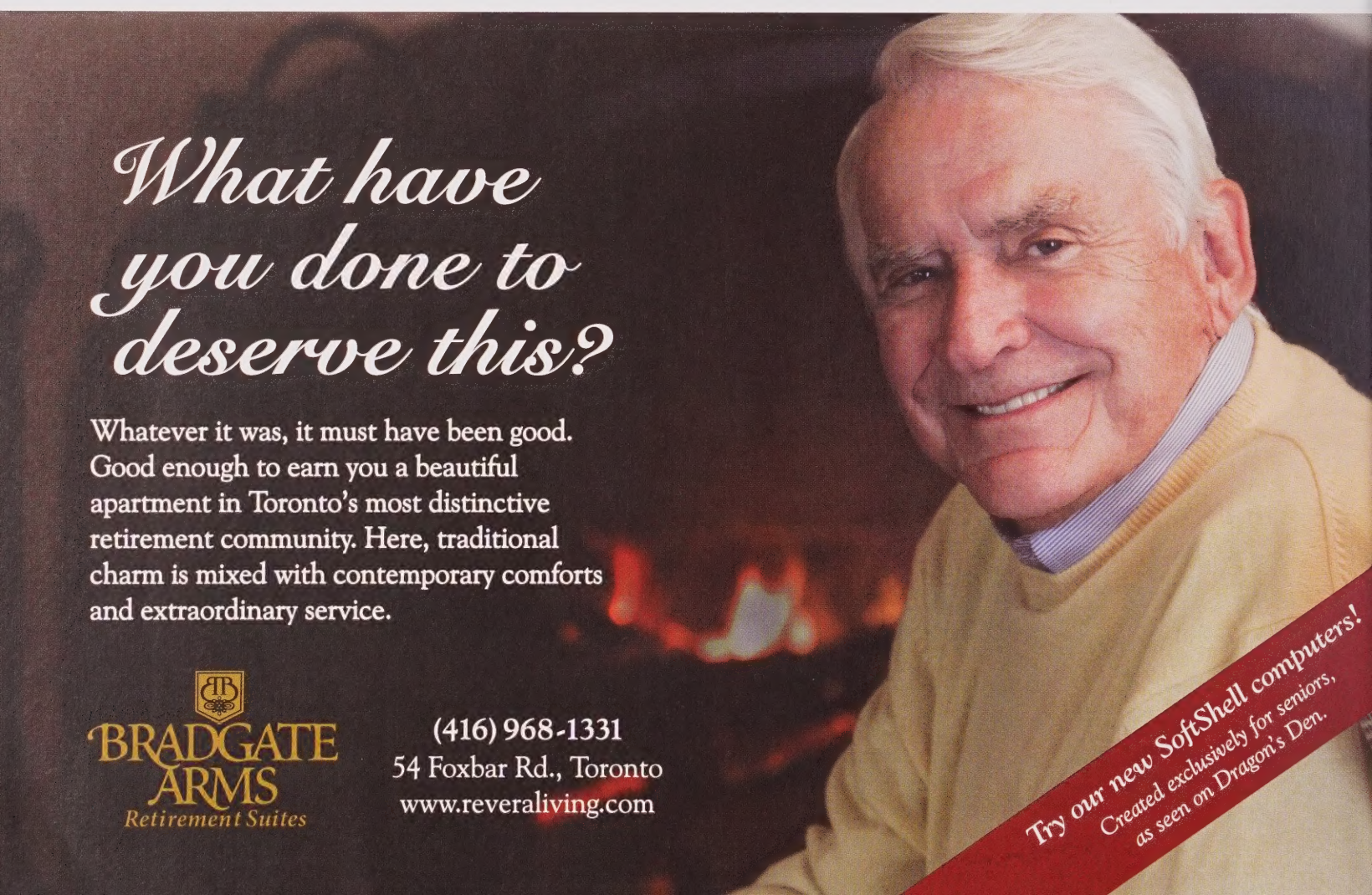
How do you live a green life? I've got my super-saver shower head and long-lasting light bulbs, I don't have a car (I bike or walk), and I've cut back on beef.

Steven Spencer
INTERPRETIVE PLANNER

The ROM has been Spencer's ("Life in the Time of the Dead Sea Scrolls") place of work for more years than he cares to recall (23, actually). As an interpretive planner, he has written text for a great many gallery and exhibition projects, each one a unique experience. Spencer was very pleased to be asked to help plan the *Dead Sea Scrolls* exhibition, since the topic has intrigued him since his 20s. He has always found the two foundational heritages of Western culture, the Greco-Roman and the Judaeo-Christian, to be richly interesting.

How do you live a green life? I've composted for years, buy organic and local food, decry the planned obsolescence and excessive packaging of so much that we buy, and can't wait for the plug-in electric car.

What's the best part of your job? Interacting with curators in the earliest planning phase of an exhibit, when ideas flow most freely, when I can immerse myself in the subject, however fleetingly, and when the sky is the limit. . . .


What have you done to deserve this?
Whatever it was, it must have been good. Good enough to earn you a beautiful apartment in Toronto's most distinctive retirement community. Here, traditional charm is mixed with contemporary comforts and extraordinary service.
BRADGATE ARMS
Retirement Suites
(416) 968-1331
54 Foxbar Rd., Toronto
www.reveraliving.com
Try our new SoftShell computers!
Created exclusively for seniors, as seen on Dragon's Den.

A Letter from our Director and CEO

Nature—The Greatest Story of All

With the opening of the ROM's newest natural history galleries, visitors will encounter two distinct metaphors as aids in understanding nature.

The first metaphor—the "Tree of Life"—deals with evolution. Its roots extend back several billion years, and its branches have grown and changed through the process of natural selection. It describes the proliferation and change of species over time. The Tree of Life will define the entrance of the Peter F. Bronfman Gallery of Early Life, to be built in the last tranche of Renaissance ROM.

The second metaphor—the "Web of Life"—describes an ecosystem, the interconnectedness of species alive at the same time across space. It is explored in the Schad Gallery of Biodiversity, which opens this May on the second floor Centre Block of the Museum.

The Tree of Life is an astounding graphic. In its lower left corner the story starts some three billion years ago with blue-green algae and bacteria, leading to slime molds, green algae, and fungi. These simple ancestors of ours prevailed for, well, eons.

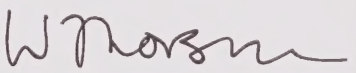
The animal kingdom comes into sight about 800 million years ago, and erupts into marvelous complexity in the oceans 520 million years ago in what is known as the Cambrian Explosion—the "Big Bang of Life." This burst of complexity and variety occurs in a very short moment of geological time—perhaps as short as 15 million years. It is the miraculous basis upon which all fauna subsequently appeared and disappeared through natural selection—many, many species expiring through extinctions small and great, creating conditions for others to grow and develop.

As this "tree" reaches up and out over time, the Earth itself evolves: continents drift, comets hit, volcanoes erupt, and temperatures change. *Homo sapiens* arrives very recently and we come into our own during the relatively cold last 50,000 years.

At the beginning of the Bronfman Gallery, we will show the entire Tree of Life, leading to the present day through the five great extinctions of which the dinosaurs were just the last. (Are we the next?) And we will offer the world's most authoritative fossil record of the Big Bang of Life from our collection of the Burgess Shale.

This year is the 100th anniversary of the discovery of this ancient seabed of fossils, raised thousands of metres into the Rocky Mountains near Golden, British Columbia. (We mark the occasion with a special exhibit.) The Smithsonian Institution in Washington, D.C., and the ROM were the only museums granted permission by Parks Canada to dig the Burgess Shale over this century. The ROM's new Bronfman Gallery will present the results thoroughly and clearly for the first time in the history of this Museum, telling the tale of life's origins, arriving eventually at the dinosaurs. Finally, the story leads into the Schad Gallery of Biodiversity, with the life forms of our own time.

The Schad Gallery's revelations about the Web of Life are described elsewhere in this magazine, and are as gripping as the story of evolution will be in other galleries. The story of nature, tree or web, is the greatest novel of them all.



WILLIAM THORSELL
DIRECTOR AND CEO

ROM
Royal Ontario Museum

ROM
The Magazine of the Royal Ontario Museum

Executive Editor
Victoria Littler

Managing Editor
Lee-Anne Jack

Design and Production
Hambly & Woolley Inc.

Consulting Editor
Anna Kohn

Copy Editor
Andrea Gallagher Ellis

Photography
Brian Boyle (unless otherwise indicated)

Contributing Editors
Mary Burridge
Glen Ellis
Mark Engstrom
Peter Kaellgren
Dave Rudkin
Kevin Seymour
Janet Waddington

Business Development Manager
Colin Hennigar
416.586.5546

Editorial and Marketing Offices
ROM, the magazine of the Royal Ontario Museum
100 Queen's Park
Toronto, ON M5S 2C6
Phone: 416.586.5585
E-mail:
lee-anne@rom.on.ca
ROM website: rom.on.ca

Published four times per year by the Royal Ontario Museum Governors through the generosity of the Louise Hawley Stone Charitable Trust.

© The Royal Ontario Museum, 2009.

Printed and bound in Canada. Indexed in the Canadian Periodical Index and the Canadian Magazine Index and available on-line in the Canadian Business & Current Affairs Database ISSN 1911-947X and through Thomson Gale.

Canadian Publications Agreement #40068986.

Return undeliverable Canadian addresses to:
Royal Ontario Museum
Membership Department
100 Queen's Park
Toronto, ON M5S 2C6.

Subscriptions and Single Copy Sales
Subscriptions cost $17 (4 issues) including GST; outside Canada add $8 for postage and handling; single copies cost $5 plus GST.

All circulation and subscription inquiries should be addressed to:
ROM Magazine
Royal Ontario Museum
100 Queen's Park
Toronto, ON M5S 2C6
Phone: 416.586.5546
Fax: 416.586.5649
E-mail:
magazine@rom.on.ca

FSC
Mixed Sources
Product group from well-managed forests and other controlled sources
Cert no. SGS-COC-005437
www.fsc.org
© 1996 Forest Stewardship Council

ROM Magazine is printed on paper from well-managed forests and is chlorine and acid free.

Buy it for looks. The ones you're inevitably going to get.

The new GLK is like no mid-sized SUV you've ever seen. Its forward style demands attention. And it drives like no SUV you've ever driven. Mercedes' award-winning fourth-generation 4MATIC™ permanent all-wheel-drive system gives you control, off-road or on-, while AGILITY CONTROL makes for a suspension and steering that's taut, responsive, and entirely civilized. For a more intimate look, visit **mercedes-benz.ca/glk**. The GLK. **You've never seen a Mercedes like this.**

The All-New 2010 GLK. Starting from $41,800.

© 2009 Mercedes-Benz Canada Inc.

Mercedes-Benz

Exhibitions and gallery openings

ROM Members will be offered a special sneak preview of the gallery. Go to **rom.on.ca** for details.

In the Spotlight

May 2009 **Gallery Opening**

NEW The Schad Gallery of Biodiversity

From Arctic tundra to tropical rainforests, life is found in abundance—in places as inconspicuous as a pinch of city soil and as eye-catchingly obvious as vast herds crossing the African savannah. Biodiversity, the variety of life on earth, is spectacular in its range and complexity. And the species we know are a mere fraction of what exists.

In the natural world, there are numerous ecosystems, and each species, including humans, plays a role in the complexly interconnected web of ecosystem life.

The Schad Gallery of Biodiversity is a tribute to life on earth, displaying thousands of species—colourful beetles, schools of sharks, and some of the largest mammals from North America and Africa. There's even a coral reef aquarium. Fifteen interactive touch screens display some 150 videos. The gallery not only explores the negative effects humans have on our fragile earth, but suggests how individuals can play a part in preserving our living natural legacy.

MARY BURRIDGE is assistant curator of Ichthyology

The Earth Rangers Studio, the centrepiece of the Schad Gallery of Biodiversity, will feature on-site instructors, live animal shows, and state-of-the-art multimedia presentations on the latest scientific research, news, and relevant issues.

Until July 5, 2009 **Feature Exhibition / ICC**

Roloff Beny Gallery, Fourth Floor of the Michael Lee-Chin Crystal.

NEW Housepaint, Phase 2: Shelter

Graffiti has been with us since ancient times. Unauthorized scratchings on public walls have been found in the catacombs of Rome, on the bases of ancient Greek vases, even on the pyramids. Street art, like graffiti, is a means of public discourse, a visual discussion between anonymous artists painted late at night. It's a way of laying claim to public space for dialogue that goes beyond advertising. As American street artist Dan Witz says, "Street art has its roots in rebellion." It draws attention to subjects that otherwise aren't addressed—subjects like homelessness in Canadian cities.

In 1998, Toronto's Tent City spontaneously arose on the shores of Lake Ontario, a response to soaring rents, cutbacks, and a shelter system bursting at the seams. By 2002 it was occupied by more than 200. All were suddenly evicted in September 2002, ostensibly because of ground contamination.

Canada's first exhibition of street art in a major museum, *Housepaint, Phase 2: Shelter* presents the personal responses of 12 leading outdoor artists to the problems of homelessness and poverty in Toronto. Ten framed canvas "houses"—created by internationally recognized Canadian street artists Cant, Case, Dixon, EGR, Elicser, Evoke, HVW8, Lease, and Other—form the cornerstone of *Housepaint*. The show explores the legitimacy of street art and graffiti, an effective means of engaging youth, activists, people with low incomes, and the public in a dialogue about the legacy of Tent City. *Programs Partner: Habitat for Humanity*
Media Partner: NOW *magazine*

When the exhibition closes, the canvas houses will be auctioned, with proceeds going to Habitat for Humanity Toronto.

Photo: Canvas house, Tyler Young

Out of the Vaults

Until mid-September 2009
Ongoing Exhibition
Daphne Cockwell Gallery of Canada: First Peoples

Sitting Bull's Headdress

The great Sioux warrior's bonnet, c. 1875, remains on temporary display.

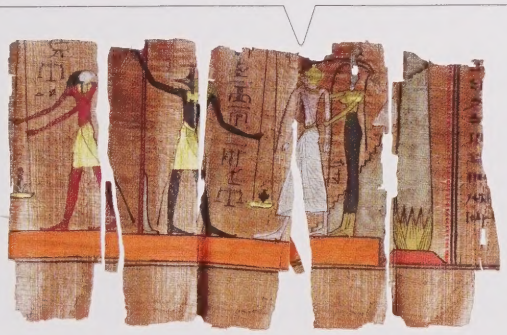
NEW

Until May 10, 2009

Book of the Dead

The *Book of the Dead* was hugely popular throughout ancient times in Egypt, and many people had their own personalized version which would include their favourites among the 200 or so known chapters. Often called "spells," the chapters imparted information critical for the deceased to get through the dangers of the underworld and achieve paradise in the next life. These decorated ancient Egyptian papyri show clearly that the illuminated manuscript was a tradition born in ancient Egypt.

The ROM's *Book of the Dead* was declared by University of Bonn *Book of the Dead* expert Dr. Irmtraut Munro likely the finest in the world of its date, about 320 BCE. The beauty of the drawings, the amount of gold applied to its pages, and the gracefulness of the writing all combine to make it a stand-out.



Until April 26, 2009 Ongoing Exhibition
Second Floor, Hilary and Galen Weston Wing

A Fossil Paradise: The Discovery of the Burgess Shale by Charles D. Walcott

In 1909, on a distant ridge in British Columbia's breathtaking Yoho National Park, American paleontologist Charles D. Walcott opened a fascinating window into the history of life. As it turned out, the Burgess Shale, now a UNESCO World Heritage Site, held a rich deposit of fossils—odd, primitive life forms dating to 505 million years ago. It was the first time scientists had seen creatures like the fantastical *Morella splendens* and the aptly named *hallucigenia*.

To mark the 100th anniversary of the site's discovery, and the Museum's own role in collecting and researching these early life forms, the ROM presents *A Fossil Paradise*. Highlights are Walcott's vintage photographs and original notebook, and of course specimens of the "wonderful life" that gave scientists new insight into our living past.

Until mid-December 2009
Ongoing Exhibition
Gallery of Gems and Gold, Level 2, Weston Family Wing

Light & Stone: Gems from the Collection of Michael Scott

Have you ever suspected a jewellery dealer wasn't providing exactly what was promised? So did Michael Scott. A garnet he ordered turned out to be a synthetic material worth a tiny fraction of the garnet's value. But for him, the incident was inspirational: it sparked an enduring fascination with gems. Today Scott has amassed a collection rivalled by few outside royal families. The ROM presents 200 unmatched specimens from his collection of precious stones, gem crystals, jewellery, and gem artworks.

Photos: Gems, Erica and Harold van Pelt Photography. View of Fossil Ridge. © J.B. Caron. All rights reserved.

China's famous Qianlong emperor (r. 1736–1795) is being carried by eunuchs across the Grand Canal in a sedan chair. This is one of 12 monumental scrolls by court painter Xu Yang that document the emperor's southern inspection tour in 1751.

Until September 7, 2009
Feature Exhibition
Herman Herzog Levy Gallery, First Floor, Philosophers' Walk Wing

NEW Brilliant Strokes: Chinese Paintings from the Mactaggart Art Collection

During China's Ming and Qing dynasties, a myriad of painting techniques proliferated. There was *baimiao* (plain drawing), *shuanggou* (double outlines), *gongbi* (meticulous drawing), *xieyi* (jotting down ideas), and *mogu*, also called "boneless" (images rendered in washes with no contours). It was also a time when the importance of artists and literati was paramount. They often discussed paintings at social occasions, even writing their own commentary and inscriptions on the works in the form of colophons and seals. *Brilliant Strokes: Chinese Paintings from the Mactaggart Art Collection* exhibits 17 works from one of the most important private collections of Chinese paintings and textiles in Canada, which was donated to the University of Alberta by Sandy and Cécile Mactaggart in 2005. The exhibition offers an opportunity to examine some of the finest examples of Chinese works from the 15th to 20th centuries.
This exhibition was organized by the Mactaggart Art Collection, University of Alberta Museums, University of Alberta.

BEYOND THE EXHIBITION: The ROM offers courses in Chinese brush painting at introductory and intermediate levels. Cost is $180 for the public (online $175) and $160 for ROM Members (online $155) plus materials. For details, visit **rom.on.ca/programs** or call 416.586.5797.

Until July 5, 2009 **Ongoing Exhibition**
Third Floor, Samuel European Galleries

Wedgwood: Artistry and Innovation

Josiah Wedgwood was clever. The renowned founder of the Wedgwood pottery was not just adept at discerning trends, he had an instinctive understanding of marketing. He persuaded English ambassadors to promote his ceramics at European courts. And as far back as 1765 he recognized the value of a celebrity endorsement. Queen Charlotte, wife of George III, wrote Wedgwood that year to compliment him on a cream-coloured earthenware tea set. Wedgwood lost no time in seeking and ultimately securing the privilege of calling it Queen's ware.

Always the innovator, Wedgwood continually developed new ceramic lines, often drawing on the popular taste for antiquity, neoclassicism, and vases. And he successfully experimented with the latest technology to improve products and productivity. The Wedgwood factory has continued the founder's tradition of excellence for 250 years. The ROM exhibition *Wedgwood: Artistry and Innovation* showcases 160 pieces dating from Josiah's days to the present, drawn almost exclusively from the Museum's outstanding ceramics collection, the finest in Canada.
Paint generously donated by: Farrow & Ball.

A dinner plate from the Queen's ware "Husk" dinner service ordered by Empress Catherine II of Russia in 1770 is displayed in the exhibit.

Last Chance

Until March 22, 2009
Third Floor, Centre Block

Mysteries of Ancient Ukraine: The Remarkable Trypilian Culture

Take this last opportunity to explore the ancient sophisticated culture that once existed in what is now Ukraine.
Presenting sponsor: Northland Power. Exhibition patron: Ukrainian Canadian Foundation of Taras Shevchenko. Benefactor: Dopomoha Ukraini Foundation and Wrzesnewskyj Family.

Photos: Scroll painting, © University of Alberta Museum. Wedgwood, Royal Ontario Museum © 2008. All rights reserved.

Thinking Green

It may just be another resource for consumption

BY MARK KINGWELL

Every year since 1976, linguists at Lake Superior State University in Michigan have compiled a list of words so irritating and dumb—so misused, overused, and generally useless, as they put it—that the only solution is "banishment from the Queen's English." Past winners of this dubious honour include word burrs ("you know"), pointless redundancies ("at this point in time"), chummy jargon ("user-friendly"), and insincere nonsense ("have a nice day"). The 2009 list, which also denounced "maverick," "staycation," and "bailout," was headed by a possibly surprising entry: "green."

"The ubiquitous green and all its variables," the editors noted, "such as going green, building green, greening, green technology, received the most nominations." As one respondent put it, "If I see one more corporation declare itself 'green,' I'm going to start burning tires in my backyard."

It's not clear what, precisely, is tire-burningly objectionable about green: mere ubiquity, or the hint of falseness in claims of environmental friendliness? (Personally I find "environmentally friendly" more annoying than "green"; but it's not my list.) "Green" has been handy shorthand for things environmental at least since the founding of green parties in Europe during the late 1970s. True, it's overused, and true again, corporate claims of environmental responsibility are often oversold. But like the word or not, trust the company or not, what counts as green technology anyway?

There is no such thing as a viable green option with fossil fuels; even hybrid forms only slow, rather than stop or reverse, consumption of the resource

It is perhaps easier to answer this question through what philosophers call contrastive definition: depletist, or anti-green, technology is any that works by means of net resource loss. Resource destruction is not in itself depletist if the resources in question can be sustained over time, say by replanting trees or by imposing fishing quotas under reproduction rates. Primitive agricultural tools of the sort on view in a museum are likewise non-depletist, if only because they are too inefficient to reach the margins of permanent resource destruction.

Clearly, technologies that depend on resources that cannot be renewed, at least at current levels of ingenuity—fossil fuels, for example—are thus structurally depletist. There is no such thing as a viable green option here; even hybrid forms only slow, rather than stop or reverse, the permanent consumption of the resource.

My mention of ingenuity is deliberate, because one of the tenets of green technology is that we need to close the gap between existing ideas and the conditions of consumption. The argument is that, if we can just get smarter, we can fashion tools that are both efficient and sustainable.

Illustration: Bob Hambly

Perhaps so. But the background assumption here—the thought that thinking is itself a resource—is perhaps the most dangerous tool of all, the artifact of our demise. The technological worldview, as the philosopher Martin Heidegger reminds us, is not this or that specific implement or technique. It is, rather, the idea of a world infinitely available for our use. Heidegger used the phrase "standing reserve" to describe how, under the sign of technology, everything lies in wait for possible future consumption. The forest, whether it is clear-cut or part-cut or even left alone, is just potential logs, no longer a forest.

With green technology we are consuming ourselves, and our thinking, as forms of standing reserve. Burning tires—or banning words—won't change that; but neither will building hybrid cars, signature vehicles of the idea. o

---

MARK KINGWELL is a professor of philosophy at the University of Toronto, former chair of the ROM's Institute for Contemporary Culture, and contributing editor of *Harper's Magazine*. He is the author of, most recently, *Concrete Reveries: Consciousness and the City* (2008) and *Opening Gambits: Essays on Art and Philosophy* (2008).

Discoveries, Dispatches and Discourse

This sword and its history provide interesting cultural links between the British Isles and Jamaica.

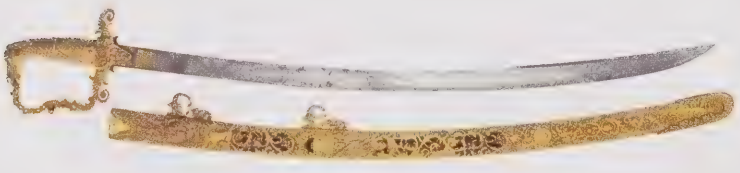
New Acquisitions

A Masterpiece in Silver Gilt and Steel

The decoration on this superb single-edged sabre is a virtual visual compendium of style and ornament in the decorative arts of Britain and the Empire of the early 1800s, a masterpiece of English cutler's and goldmith's art. Note the figures from Greek mythology: a scaly horse's head on the grip and pommel likely represent a mythical sea horse and reliefs on the grip depict Perseus and Medusa. The sword was presented to Colonel the Honourable Duncan Robertson in 1831 by the officers of the St. Elizabeth Regiment, which was stationed in Jamaica in the 1830s. Made by Salter, Widdowson & Tate, London, the sword and scabbard were acquired by the ROM in 2007.

COREY KEEBLE is curator of European Arts

Acquired from Mr. Paul Robertson, Deseronto, Ontario, with a grant from the Louise Hawley Stone Charitable Trust.



Design Notes

In October 2008, *ROM* Magazine hired design firm Hambly & Woolley Inc. to collaborate with us on a dynamic redesign. We are excited about the contemporary and engaging look and feel, which will allow us to convey the depth of the ROM experience. We've also added a special section for our Members, to keep them informed of the latest membership offers, programs, and ways to support the ROM.

We'd like to thank outgoing art director Peter Enneson for 20 plus years of dedicated service. We wish him all the best.

2007.69.11.6.

ICC
In Conversation

Francisco Alvarez, managing director of the Institute for Contemporary Culture, speaks with Devon Ostrom, guest curator of the ICC exhibition *Housepaint, Phase 2: Shelter*.

Francisco Alvarez: The original *Housepaint* installation at Tent City on Toronto's eastern waterfront stemmed from a Luminato proposal that Toronto graffiti artists paint at the site. Where did this idea come from?

Devon Ostrom: When local artist Specter was researching the Luminato site, he found that it was part of the former Tent City. This loaded history was fertile ground, touching on poverty, neglect, memory, homelessness, and mutual reliance. The concept of creating canvas houses as a transient memorial came to be thought of as the most appropriate response.

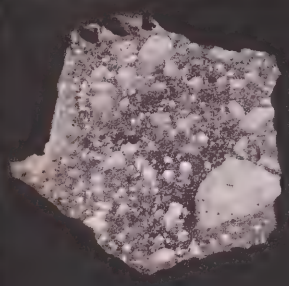
FA: Has bringing Phase 2 of the exhibition indoors influenced its development?

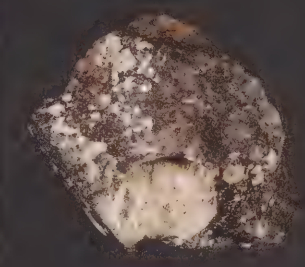
DO: Rather than just re-hanging the original, I wanted to challenge the traditional structure of exhibition programming. The "telephone game," where each of five artists responds to the previous artist's installation, is a way to bring indoors the collaborative and spontaneous qualities of street art.

FA: What is the difference between street art and graffiti?

DO: Both terms are extremely inclusive of diverse forms of expression and there is a lot of overlap. "Street art" could include mimes and street performers while "graffiti" encompasses everything from ancient scratching on the pyramids to the style of graffiti and subway art made famous in the late '70s and early '80s in Philadelphia and NYC. Street art encapsulates a greater political, community, and pictorial focus, while for graffiti artists the focus is on cryptic letter forms. What they have in common, at their best, is a desire to enhance public spaces and make art accessible.
The public can view the artists in progress both in person and online at www.housepaint.ca.

The Institute for Contemporary Culture (ICC), the Museum's window on contemporary societies, is committed to presenting provocative examinations of current global cultural and social issues through art exhibitions, lectures, film series, and more. For information on upcoming events, including *Housepaint*-related programs, visit **www.rom.on.ca/icc/events**.





News

Lunar Highlands' Largest Meteorite

Tells Us About the Making of our Moon

Larger than any moon rock brought back by the NASA Apollo mission, a 9.6-kilogram meteorite now on display at the ROM is the largest known piece of the lunar highlands in existence. Its composition confirms a theory of our moon's origin: as Earth was forming some 4 billion years ago, it was involved in a catastrophic collision with another celestial body. The other body was obliterated on impact and its remnants circled the yet-unfinished Earth. Material from the two bodies combined to eventually form our moon.

From the Archives

Commemorating a ROM Legend

Saying Goodbye to C. T. Currelly

When Charles Trick Currelly passed away on April 10th, 1957, his principal legacy was the ROM itself, where he had served as founding director of the Royal Ontario Museum of Archaeology until his retirement in 1946.

The opening of the Currelly Memorial Exhibition on October 7, 1957, was marked by the unveiling of a bronze bust of Currelly cast in 1957 by the Vandevoorde Art Foundry of Montreal from an original sculpture made in 1919 by Canadian-born artist Ulric Stonewall Jackson Dunbar.

The ROM Board of Trustees based the commemorative bust on Dunbar's cast even though archival records indicate that Currelly was not particularly fond of it because it portrayed him as a young man. Official approval to spend the $350 for the casting was noted in a memo from the Board secretary just two weeks before Dr. Currelly's passing.

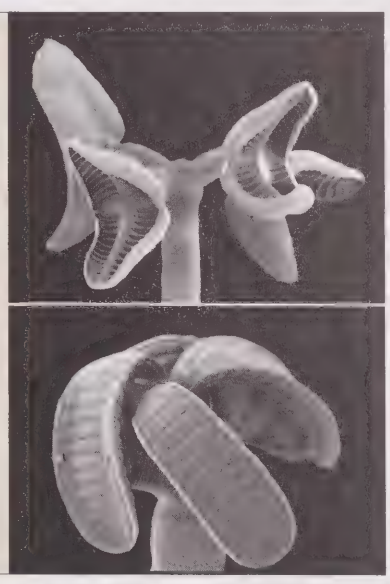
The bust and a bronze medallion also by Dunbar may be viewed in the ROM's Sackler Reading Room.

ARTHUR SMITH is head of the ROM's Library and Archives

Tapeworm Relationships

A New Worm Order

A new study on tapeworms by ROM curator Claire Healy has made the cover of the high-profile *International Journal for Parasitology*. With international colleagues, Healy reclassified a group of tapeworm species, most of which parasitize stingrays, into a new order, which includes five genera new to science. Future research on other orders may elucidate how these worms made the evolutionary transition from marine life to freshwater and terrestrial lifestyles. See the study in the journal's March 2009 issue.



Photos: Canvas by Other, Tyler Young, Devon Ostrom, Che Kothari. Meteorites, © The Hupé Collection. Tapeworms, Claire Healy

Monkeying Around

One of largest arboreal frogs in the New World tropics is the tree frog *Phyllomedusa bicolor*, also known as the monkey frog. This distinctive denizen of the lowland tropical forests of northeastern South America and the Amazon basin has cat-like eyes and long, skinny limbs. The frog gets its name from a tendency to walk, unlike most other frogs, which hop. During the day, monkey frogs hide from predators high in the canopy, where they assume a "water conservation" position. To prevent themselves from drying out, they tuck their limbs close to their bodies—this minimizes their exposed body surface area—and rest.

The frogs make nightly excursions to the forest floor, presumably to feed and locate mates, before climbing back up to their daytime perches.

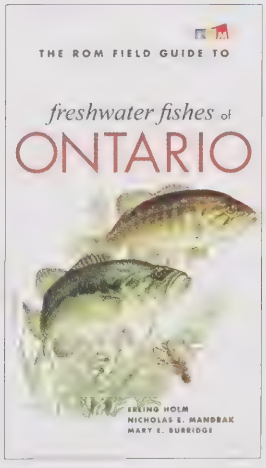
The monkey frog is well known to the Matse and Mayoruna Amerindian tribes of western Amazonia. Their interest is in a waxy poison these frogs secrete from thickened skin along their backs when agitated. When tribal hunters ingest the waxy secretions, they become violently ill and then fall into a deep sleep. Upon waking, they are able to hunt for days without need of food or water.

AMY LATHROP is the technician in Herpetology

Book Shelf

Wedgwood: Artistry and Innovation

The vast popularity of Benjamin West's epic canvas *The Death of General Wolfe*, an original copy of which is at the ROM, led to mass reproduction of the image in late-18th century England. Josiah Wedgwood I (1730–1795) applied a transfer-printed version to jugs, teapots, and other ceramics. *Wedgwood: Artistry and Innovation* celebrates the beauty and mystique of this classic English pottery and spotlights the ROM's collection. $20.



The ROM Field Guide to Freshwater Fishes of Ontario

Ontario is home to the greatest diversity of freshwater fish anywhere in Canada, its species ranging from the least darter, measuring only a few centimetres in length, to the ancient lake sturgeon, which can be longer than 2 metres. This addition to the best-selling Ontario field-guide series is a must for the angler, naturalist, and cottager. $29.99.

GLEN ELLIS is head of Publications at the ROM

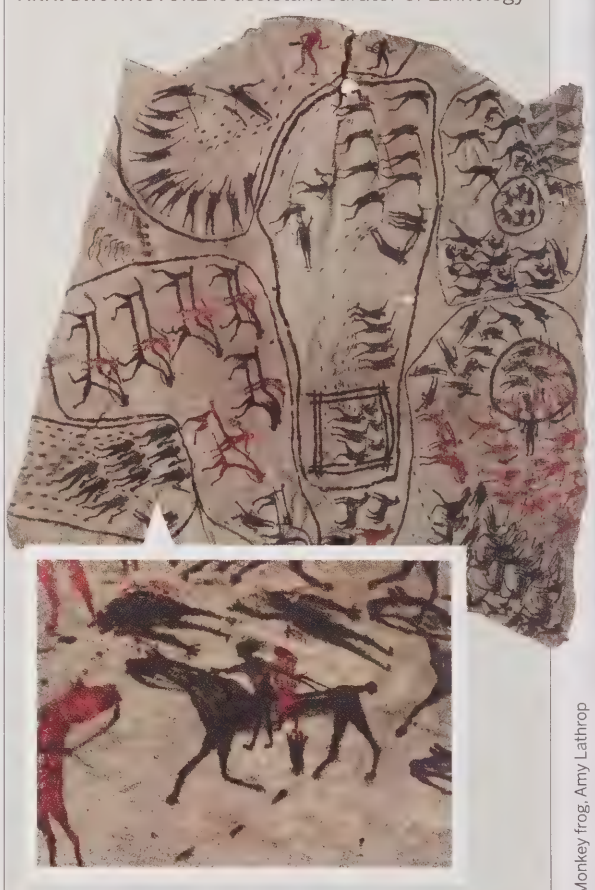
Spotlight on the Collection

The Making of a War Robe

In the summer of 1908 Canadian-born artist Edmund Morris brought a buffalo robe from Toronto to the Tsuu T'ina (Sarcee) Reserve near Calgary and asked government interpreter, George Hodgson, to have it painted with a pictographic record of Chief Bull Head's battles with the Cree in the 1860s. Morris had travelled to most of the Canadian Plains Indian communities to portray important leaders. Larger than life, Bull Head was a physically imposing figure with a booming voice and a commanding personality. Known for his bravery, he was a tribal chief from 1865 until his death in 1911—the Tsuu T'ina's greatest leader in living memory. (He was a perfect subject for Morris's portrait, which is in the ROM's collection.)

Bull Head narrated his deeds in great detail and Hodgson's daughter, Katherine, transcribed the narrative translated for her from the Sarcee. "Tribal recorder" Two Guns did the robe painting, drawing lines around each of six depicted exploits and inscribing each with a number that keyed it to the written explanation. The figures were colour-coded: the Cree were blue and the Tsuu T'ina red and green.

ARNI BROWNSTONE is assistant curator of Ethnology



Read more about Brownstone's work on page 15.

Photo: Monkey frog, Amy Lathrop

The Lost Shepherd

This religious carving is one product of Goa, Europe's luxury outpost in India during the 1600s

BY PETER KAELLGREN

Q My wife and I recently visited the Museum, and we were surprised to see a carving in one of your display cases almost identical to one we have. About 50 years ago, my father was digging a basement for a house in Toronto's west end in the Scarlett Road area and uncovered a carving. It is very like one at the ROM, a small figure of "The Good Shepherd" from Goa, India, dating to the 1600s. I am curious about the obviously learned man with a wig and large book open in front of him in our carving as well as the animals and the throne with the head at the top. — J. S., Woodbridge, Ontario

A Thank you for your letter.

Your figure, like the ROM's, likely comes from Goa, India. In 1510, the Portuguese set up this colony along India's southwest coast. By the early 1600s, Goa was the largest European settlement in the entire Far East, popularly referred to as "The Rome of the East" because of its many churches. The Portuguese were devoutly Roman Catholic and erected spectacular Baroque churches in Goa during the 1600s when they were becoming wealthy from international trade and from their colonies around the world.

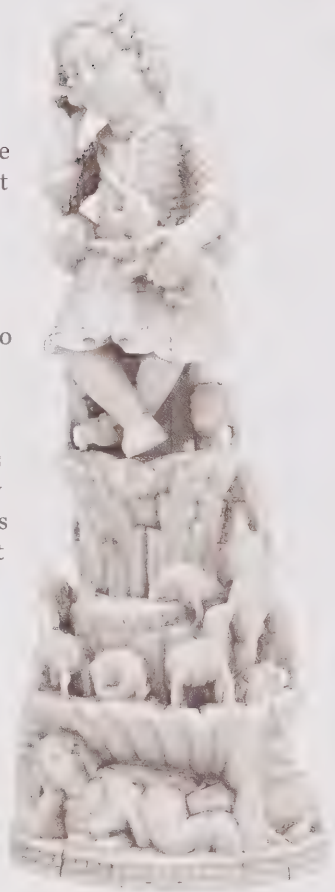
At the height of its fame in the 1600s, Goa attracted trade and many visitors. It boasted an entire street of goldsmiths who made jewellery and precious objects. Local carvers of elephant ivory probably took the idea of sculpting these miniature figures of The Good Shepherd from imported European carvings. Catholic priests and other church officials would have brought religious objects and books of prints with them to India. Some orders, such as the Jesuits, may have had brothers with practical knowledge of the visual arts. I don't believe there has been a full study of the range of carvings like yours. Usually, they date anywhere between around 1600 and 1700.

The imagery in these figurines is always rather similar. The figure at the top is a curly-haired Jesus as a young shepherd, holding a lamb under his arm. This piece was sometimes carved separately as yours would have been, since the hole at the top of your base indicates where an ivory, wood, or metal pin would have held the carved shepherd in place. The figure looks quite different from the bearded Jesus popularized by European artists during the 1800s. The imagery reflects the teachings of Jesus in which he often likened God's love to that of The Good Shepherd who would sacrifice his life to protect his sheep. Figures of sheep are carved around the mound, whose conical shape is perhaps dictated by the tip of the elephant tusk from which it is carved.

Directly below Jesus is a sort of cup shape. The ROM's example is more intact than yours and has carved sprays of water, which identify the image as the spring of living water referred to by Jesus. The lion's head above is probably another water source, as many European fountains had water flowing from lion's heads.

The figure at the base, which you have understood as a learned man, is difficult to identify with certainty. Again, the ROM's example is more intact and appears to show the man writing in a book with a quill pen, in which case he could be one of the four Evangelists who compiled the Gospels. The lions in the niches to either side suggest St. Mark, who is regarded as a scholar. I'm not certain of this identification, though, as often figures in the lowest level directly below Christ are intended to suggest his lineage. Referring to the Old Testament idea that Jesus is a son of the royal House of David, the figure could be Jesse. Ultimately, it may be possible to discover a print or sculptural source that could clear up the interpretation. But one has to allow a certain degree of artistic license to the Indian carvers who were interpreting a subject that was likely unfamiliar to them.

As to how your carved base for the figure ended up in a house excavation in Weston, Ontario, I can only speculate. Given the staining and cracks in the ivory, it seems likely it was in a fire. If it had simply been lost, it would have been more intact and less charred. During the 1800s, many British men who had served in the military or colonial civil service in India settled in Canada. Often, they brought interesting curiosities with them. Evidence of this Indian connection can be seen in Delhi, Ontario, and in Benares Historic House in Mississauga, the family home that provided the model for the Jalna series of books by Mazo de la Roche. There is a remote possibility that your figure may have come to Ontario with an early Jesuit missionary since the Jesuits were very active with the Huron Nation. Their work is commemorated by the historic site Sainte-Marie among the Hurons. You may want to research the history of the area where your father found the figure to determine what may have happened there prior to 1950. o



Above: The ROM's Good Shepherd carving. Miniature figures of The Good Shepherd grouping carved from ivory in Goa, India, usually date between 1600 and 1700. J.S.'s is the base only. The figure of the shepherd is missing.

PETER KAELLGREN is curator of European Decorative Arts in the ROM's Department of World Cultures.

925.13.95

Digging the Andes

ROM archaeologist uncovers modern trends in ancient Peru

BY LEE-ANNE JACK

Dr. Justin Jennings
ASSOCIATE CURATOR
Department of World Cultures

Academic Positions
2006-present
Assistant Professor
Department of Anthropology, University of Toronto

2005-2006
Visiting Assistant Professor
Department of Anthropology, Franklin and Marshall College

Education
2002
Ph.D. in Anthropology, University of California, Santa Barbara

Globalization. It's a term we're all familiar with. But to describe the ancient world? For Justin Jennings, a ROM archaeologist who has been studying the Wari society of Peru for more than 12 years, the telltale signs are there: increased movement of goods, people, and ideas across the landscape radically changing peoples' lives. Jennings believes that leaps in interregional interaction occurred multiple times in Peru's past, triggering cultural consequences that are in many ways similar to what we are experiencing in today's globalized world.

The University of California graduate first went to the Cotahuasi Valley in southern Peru in 1997. A 12-hour bus ride from the city of Arequipa, his field site is spectacularly located in the world's deepest canyon. Jennings started the project thinking that the Wari culture of 600 to 1000 CE was an empire, and he expected to uncover evidence that the Wari were conquerers.

But that's not what he found. As in other regions of Peru, Jennings found pervasive Wari influence on local pots, textiles, and stonework. Yet there was little evidence of direct contact between Cotahuasi and the Wari capital 300 km away. This seeming contradiction led him to think more about what "style" means. "If you come into a room today wearing a U of T t-shirt, what does that mean?" he says. "Asking why people in Cotahuasi were buried with Wari-style pots and textiles is a similar question."

His recent excavations have been dedicated to finding the answer. Like any archaeologist, he takes disparate clues from his dig, like the shape of a skull or the decoration on a pot, and deciphers their meanings. He is thoughtful about giving back to the developing nation where he digs and is actively encouraging preservation and tourism.

Above: A Wari-style pot from the ROM's collection.

But the goal for this cross-appointed teacher of Andean archaeology at U of T is to understand the past. It's a curiosity that has been there since childhood, when Jennings pored over pictures and stories about the Roman and Aztec empires and dug up the backyard seeking remnants of history.

But discovering what happened in Peru is more than the satisfying of curiosity. "Looking back on the past gives us a better sense of our own world," says Jennings. "To me, we are creating an artificial divide between the ancient and the modern when we don't use terms like globalization to describe past events. The spread of Wari civilization caused cultural changes just as monumental as those we are experiencing today. After all," he points out, "what is so unique about now?" o

JUSTIN JENNINGS is co-editor of the book *Drink, Power, and Society in the Andes* and is working on another tentatively titled *The First Globalization*.

CORN BEER CONFRONTATIONS
Chicha, or corn beer, is exceptionally important in Andes hospitality and was critical to ancient economies. But when ROM archaeologist Justin Jennings asked a villager how much was drunk at fiestas, the man rose angrily, exclaiming, "*Chicha . chicha* . . . who has been telling you I drink *chicha*?" Another villager claimed to drink one glass a week," says Jennings. "Then, three drinks into the discussion he challenged me to a drinking contest." Jennings learned to ask the women.

931.11.14. Photo: Beer drinker, © 2009 Bartosz Dobrzycki

MANITOBA

Dave Rudkin
ASSISTANT CURATOR
Invertebrate Paleontology

Exciting new fossil discoveries in 445-million-year-old (Late Ordovician age) rocks in central and northern Manitoba are the focus of Dave Rudkin's research. At two widely separated areas, outcrops of ancient tropical seabed deposits contain extraordinarily well preserved remains of invertebrate animals rarely encountered elsew oe crabs and other odd joint-legged animals—even entirely soft-bodied jellyfish. This joint project with colleagues at the Manitoba Museum and University of Saskatchewan is revealing some fresh and often startling insights into the ecology and evolutionary dynamics of life in shallow Ordovician seas.

NORTH AMERICA

Arni Brownstone
ASSISTANT CURATOR
Ethnology

Five pictographic paintings recording the exploits of 14 Tsuu T'ina (Sarcee) warriors are the subject of Arni Brownstone's current research. The paintings, commissioned between 1905 and 1908 by non-Natives, are accompanied by unusually rich documentation, and Brownstone is exploring the dynamic between the two cultures involved in their production. One painting is at the ROM, but the Museum Volunteers Acquisition & Research Fund enabled Brownstone to examine in person two in New York and one in Seattle. Shortly he will meet with tribal elders and study the final painting at the Tsuu T'ina First Nation, 10 km from the centre of Calgary.

BORNEO

Chris Darling
SENIOR CURATOR
Entomology

Chris Darling is setting up an insect-sampling program in Gunung Mulu National Park to inventory a group of small parasitoid wasps of the superfamily *Platygastroidea*. These insects are virtually unstudied there even though Borneo is a hotspot for biodiversity and was identified as a priority area by the Platygastroidea Planetary Biodiversity Inventory project, which is studying these insects around the world. In Borneo, insects will be trapped in a variety of forest types and altitudes, allowing Darling's team not only to assess the park's overall species richness but also to identify the areas most in need of conservation. Many new species will undoubtedly be collected and described as a result of this fieldwork.

PALAU

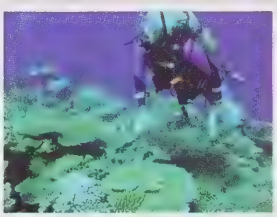
Rick Winterbottom
SENIOR CURATOR
Ichthyology

In September 2008, Rick Winterbottom visited the South-West Islands of Palau, his latest research trip for a larger study on the relationships and biogeography of Indo-Pacific reef fishes. This part of Palau had never been sampled. Little is known about the fishes in many areas of the tropical Indo-Pacific, and such research trips, by documenting local species, help to fill in the gaps. On every trip, Winterbottom has collected several species new to science. The knowledge gained from this work helps in the ultimate analysis of how fishes came to be where they are, and how they are related to one another.

CHINA

Chen Shen
SENIOR CURATOR
Archaeology

During a decade of archaeological fieldwork in northern China, Dr. Chen Shen and his team identified the earliest hominid occupations in East Asia. Shen's research concludes that early hominids (likely *Homo erectus*) arrived at the Nihewan Basin located some 150 km from Beijing more than 1.7 million years ago. They left abundant traces of their activities, including stone tools that show wear marks from use. The ongoing search for Nihewan hominid fossils in the area will continue to shed new light on human evolution.



Where in the world are they?

The who, what, and where from our international curatorial team

Photos: Horseshoe crab, Courtesy of the Manitoba Museum. Wasp, Norman F. Johnson, Ohio State University. Diver, Marina Winterbottom. Stone tool, Chen Shen

Anchors Away

The fix for one threat to the world's delicate reefs is well within reach

BY RICK WINTERBOTTOM

Coral reefs—one of the Earth's most spectacular ecosystems—constitute less than 0.1 percent of the oceans' total area. Yet these systems teem with biodiversity. Some 100,000 species of plants and animals, including fishes, living in reef habitats have been named to date, and the total is thought to be 5 to 20 times that number.

Numerous threats to the well-being and continuing existence of these lively ecosystems are documented: coral bleaching, inshore pollution, and dynamiting for fish, for instance. Few of these threats are amenable to "quick-fix" solutions. But there is one threat that is remedied easily enough. Dive-boat anchors create enormous damage to the reef top's delicate stony corals.

The awe-inspiring beauty of coral reefs makes them a prime destination for scuba-divers. And because many of the most spectacular reefs occur in the world's poorest countries, they provide a much-needed source of income for local peoples. In several tourist areas in the islands of Palau alone, 20 or more boats full of divers are active each day. Since corals are very slow-growing, repair of the damage caused by even a single anchor on a single dive site can take years. One can easily imagine the damage created by dozens of anchors dropping onto the delicate corals every day.

Fortunately, many communities offering tourist diving have seen the wisdom of preserving the spectacular life that enables them to earn a living. On the reefs at many popular dive sites, large ring-bolts or permanent concrete-block anchoring sites have been installed. A single sturdy line leads from the bolt to a buoy on the water's surface: the first boat to arrive tethers itself to the buoy while subsequent arrivals tie up to the boats already there. The system works fairly well. And there is no damage to the reef—except by clumsy or careless divers, of course!

In more far-flung locales, such systems are much less likely to be found. In September 2008, I led a ROM collecting trip to the South-West Islands of the Republic of Palau where there is no tourist industry, and thus no buoys for safe anchoring. For our scientific collecting and surveying work, we needed to use two dive tenders going to different parts of the reefs twice a day. But we were determined not to damage any coral with our anchors.

We solved our dilemma by simply having the dive boats "stand off"—depositing the divers and then floating in the area without anchoring until the divers surfaced. This method sometimes causes difficulties for the boat pilots in areas of high current, but we never had a problem. And best of all, we had the satisfaction of knowing that our surveys of these pristine islands had left no trace on the delicate coral reefs. o

RICK WINTERBOTTOM is the senior curator of Icthyology in the ROM's Department of Natural History.

Much of the white sand found on tropical beaches is coral that has been eaten and processed by parrotfishes.

Some corals form boulders up to **10 metres across**, which may contain 100 cubic metres of coral "rock"—all developed from a single original polyp a little over a millimetre in width.

There are about 720 species of hard corals in the Indo-Pacific, but only a little more than 60 species in the Caribbean, possibly the result of Pleistocene glaciations.
Hard corals, or Scleractinia, have been around for some 250 million years, and grow 10 to 15 times faster during the day than at night.

Read more about Coral Reefs on page 15

This page: The rufa subspecies that flies through Delaware Bay is the smallest population of all the red knots.

Opposite: This adult in winter plumage demonstrates the powerful wing beats red knots use for sustained flight during their 30,000-km annual migration.

How one of the most endangered migratory birds is shoring up against its imperilled global flyways

The Plight *of the* Red Knot

BY ALLAN J. BAKER

Photo: Alfred Yan

One of the most magnificent sights in the world takes place at the far ends of the earth, in places like Tierra del Fuego, northwest Australia, New Zealand, and South Africa: huge flocks of shorebirds circle high in the sky, calling excitedly as they begin their arduous journey to breeding grounds in the arctic tundras of the northern hemisphere. No matter how many times I witness it, the sight fills me with awe. And no wonder: some of these migrating birds travel 30,000 kilometres annually back and forth between their northern breeding sites and the southern feeding grounds where they spend the winter.

To fuel their remarkable journeys, the birds need suitable feeding sites along their flyway, or route. I like to use the analogy of a 747 aircraft taking onboard large amounts of fuel before departure for a world-wide flight, stopping at a few widely spaced refuelling sites. Unfortunately for these birds, only a few good refuelling sites—wetlands with abundant food supplies—exist around the world. Many of these critically important wetlands face destruction or degradation, threatening many shorebird species with huge population declines and eventual extinction. In 2003, global surveys of 207 shorebird populations showed that about half were declining in number, while only 16 percent were increasing. This ranks shorebirds as the most endangered group among all species of migratory birds in the world.

My own concern for migrant shorebirds began in 1995, when my great friend and colleague, Professor Theunis Piersma of the Netherlands, inspired me with his cutting-edge ecological research on red knots. This shorebird species, a bird slightly larger than an American robin, is the ultimate long-distance migrant. Six different subspecies of red knots migrate along global flyways from southern wintering sites to discrete breeding grounds in the high Arctic tundras. To my chagrin, I realized that the *rufa* subspecies of red knot that flies through Ontario—my own backyard—had one of the smallest populations of all.

Thankfully, Brian Harrington from the Manomet Bird Observatory in Massachusetts had been conducting pioneering work, laying the foundation for understanding the flyway of this subspecies. He had discovered that these birds, which winter in Tierra del Fuego, have the longest flyway of all the knot shorebirds. They migrate north and refuel in Argentina and Brazil at key wetlands, then make a huge flight into North America, where they refuel for the final leg to the Arctic.

That same year I decided it was high time to roll up my sleeves to better understand this amazing flyway—and to get involved in applied conservation work. Rather than pressing on with my usual taxonomic work in the office and lab, I needed to head out to the field and capture and band birds so we could estimate—and try to contribute to—their survival in different parts of the flyway.

When I challenged Theunis to come along, he agreed, and became part of an international team that joined me in February 1995 in a ROM-led expedition to Tierra del Fuego, the southern terminus of the red knot flyway. Our objective was to determine how many knots were present near the town of Rio Grande, where we know these birds live when it is winter in the northern hemisphere. We aimed to catch and band a good sample, so that we could begin the task of estimating the annual survival rate of adults by recapturing them in subsequent years. On that expedition local people from Argentina joined us, including Luis Benegas from the Museo De La Ciudad Virginia Choquintol in Rio Grande and Patricia Gonzalez from Fundacion Inalafquen in the northern Patagonia town of San Antonio Oeste, about 1,400 km north of Tierra del Fuego.

Little did I know then that San Antonio Oeste held the most important wetland in Argentina. Red knots depend heavily on it to refuel during the northward migration to the Arctic. It's an ideal spot for capturing birds in our cannon nets during their northward flights from February to April each year, allowing us to sample populations for survivors in the non-breeding season and to check their physical condition. On that first expedition, we captured and banded 350 *rufa* red knots with small numbered metal bands. In future years, we fitted the birds with coloured flags with laser-inscribed characters uniquely identifying each bird. Unlike the metal bands, these flags could be read through high-powered spotting scopes, enabling us to gather much more data on survival of individuals without recapturing them. From our annual studies throughout the flyway since 1995 we have discovered that there are three discrete

Left: Patricia Gonzalez from the Fundacion Inalafquen in San Antonio Oeste in Argentina examines a captured knot to score the progress of its body moult. She is co-organizer of all international expeditions in South America and works throughout the red knot's flyway.

Middle: Adult red knots in breeding plumage land at a beach in New Jersey to feast on the eggs of spawning horseshoe crabs. The birds must compete with dense flocks of gulls for the energy- rich eggs.

Right: A juvenile at its wintering site, after migrating from the Arctic. It's in new plumage—the black tips of its primary wing feathers are only slightly worn and won't be replaced until the following year.

Photos: Patricia Gonzalez, Allan Baker. Red knots and seagulls, © Bill Dalton

Rufa red knots need about two weeks at Delaware Bay to recover from the long flight from South America and to store nutrients for the onward flight to their Arctic breeding grounds

populations of *rufa* red knots: the group we knew about spends the non-breeding season in Tierra del Fuego, but there is another in Maranhao in northern tropical Brazil, and a third in Florida. As of 2008, by far the largest population—14,800 birds—is the group that winters in Tierra del Fuego. Fewer than 5,000 birds winter in Maranhao and 5,000 in Florida. Only a decade ago these populations were much larger, but since 2000 their numbers have declined rapidly. In January 2000 we took an aerial count of the population in Tierra del Fuego, and at that time there were about 53,000 red knots.

So what caused this alarming decline? By analyzing our data on the annual survival of red knots before, during, and after the period of rapid decline, we identified two primary causes. First was the birds' late arrival at the northward migration refuelling site at Delaware Bay in the United States. Inclement weather en route or poor refuelling at stopover sites can delay migration. The timing of their arrival at Delaware Bay is critical because the birds need about two weeks there to recover from the long flight from South America and to store nutrients for the onward flight to their Arctic breeding grounds. The second cause was that food resources at Delaware Bay were depleted. Because food on the tundra is scarce when the birds arrive and because they need energy to switch from migration to breeding condition, they need to carry more nutrients than are required for the flight. During good seasons in the bay, the *rufa* red knots feed voraciously on a superabundant supply of horseshoe crab eggs and regularly reach departure weights of 180 grams or more, some of them doubling their arrival weights of 90 to 120 grams. But in bad seasons, when food is scarce, most of the birds do not reach this optimum weight, which leaves them vulnerable to starvation or freezing when they arrive in the Arctic.

From 1997 to 2002, spawning horseshoe crabs were heavily overharvested as bait for the conch and eel fisheries, and this had a disastrous impact on red knots, which were unable to refuel properly. Birds seen alive in future years were heavier when they arrived in the bay than birds that were never seen again. From May 2000 to May 2001, 37 percent fewer adults survived than in previous years, and the number of immature birds in wintering flocks declined by 47 percent. The result was that from 2000 to 2002, population size in Tierra del Fuego declined alarmingly from 53,000 to 27,000. Based on the low annual survival rate and the poor production of young in the Arctic, we built a demographic model and predicted that if this decline continued apace, the subspecies could approach extinction in as little as 10 years. Fortunately, this worst-case scenario has not transpired. Still, by 2008, the Tierra del Fuego population had declined to an all-time low of 14,800 birds—a significant enough drop that the subspecies has been recommended for endangered status in Canada.

A positive result of this applied research, which involves international teams, is that it mobilized conservation groups to pressure state and federal agencies in the US to ban or severely reduce harvesting horseshoe crabs in New Jersey and Delaware. This succeeded only partially since a strong lobby by the horseshoe crab industry diluted effective management plans. Only New Jersey has been able to maintain a ban on horseshoe crab harvesting, and only while the knots are refuelling each May, but these measures have helped to slow the rate of decline in the *rufa* populations.

Against this dismal backdrop, a team led by Larry Niles in New Jersey has formulated a plan for the red knot. In it, objectives are defined that need to be met if the population is to recover. Simply put, the supply of horseshoe crab eggs in Delaware Bay has to return to pre-1997 levels to enable at least 80 percent of the red

Poster Bird: An Amazing Journey

In 1995, the first year I began studying the endangered shorebirds called red knots, a ROM-led international team captured and banded a cohort of these birds. Most of them have long since died as, on average, the birds live only seven years. But this many years later, a lone survivor remains. In 1996 he was fitted with a coloured flag that has laser inscribed characters uniquely identifying him. Analogous to an engraved bangle or medical alert bracelet worn by humans, the band clearly identified him as bird B (95).

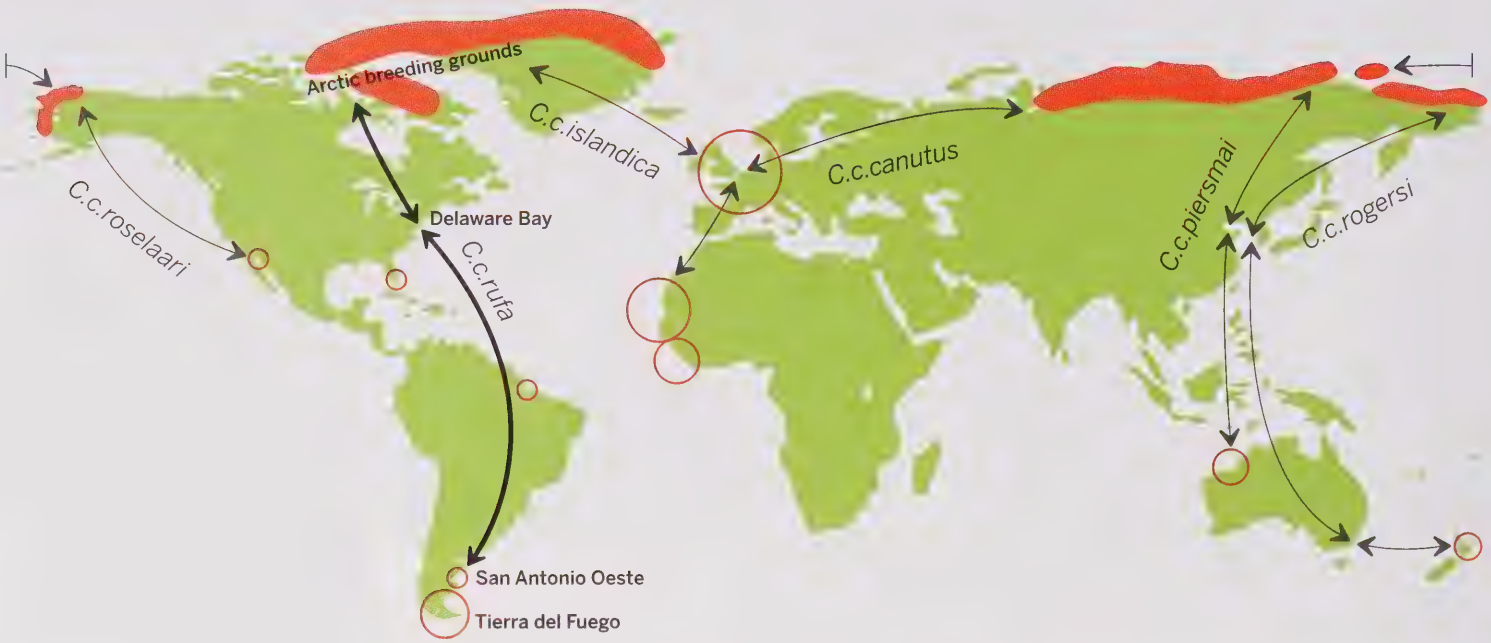
The elderly bird's fame has so attracted public imagination that some conservation agencies are using his story in their fundraising literature. We first caught him in February 1995 when he was an adult and thus at least three years old. So he is now at least 16 years of age. If we multiply 16 annual migrations by 30,000 km we get a total flight distance of 480,000 km. He has flown the average distance to the moon (385,000 km), and is on the way back to Earth! We know B (95) is male because when we recaptured him in Rio Grande in November 2007 and took a tiny blood sample, the extracted DNA showed two copies of the male-specific sex chromosome Z, whereas females have one copy each of the Z and W chromosomes. The astonishing B (95) was seen in August 2008 on the north shore of the Gulf of St. Lawrence in Quebec and we saw him again in December 2008 on our latest expedition to Rio Grande.

Photos: Juvenile knot, Peter Grube. Poster bird, Allan Baker

Rufa red knot stats

	C.c. rufa
Total migration distance annually (km)	30,000
Max. single flight distance (km)	8,000
Breeding latitude	64.13°N
Population size	14,800

Below: The flight path, or flyway, for the *rufa* subspecies of red knot is marked in black. Its wintering grounds are circled.



knot population to reach departure weights of 180 grams, and this likely requires a total ban on harvesting of crabs for about five years, or at least a small harvest until the horseshoe crab population recovers to levels high enough to sustain the birds. Based on years when birds have been able to refuel adequately, we know the knots need about 50,000 horseshoe crab eggs per square metre laid in the top 5 cm of the beaches. This requires the number of horseshoe crabs spawning on the beaches to increase to 15 crabs per trawl from the current average catch of 1 to 5 in the annual Delaware Bay trawl survey. As well, adult survival among the red knots has to be increased to the normal level of about 85 percent or more, and production of young has to be at least 20 percent, as it was in the past, so that the breeding population can expand.

Even after 13 years of close study, for us, the biggest remaining unknown about the flyway was how successful the birds were in breeding each year. Partly because breeding pairs are spread widely across the Arctic and because the juveniles diffuse across the Americas, it is hard to assess numbers. But we've now found a way to address this problem. In 1996, Quebec ornithologist Yves Aubry of the Canadian Wildlife Service alerted us to the fact that during their homeward flight after the breeding season, red knots were refuelling on the beautiful small islands in the Mingan Archipelago National Park Reserve, just offshore from Havre St. Pierre on the north side of the Gulf of St. Lawrence. Mingan offers a perfect opportunity to count the number of juveniles coming out of the Arctic, and thus a way to gauge annual breeding productivity.

So, for the last two summers my ROM team has been working at Mingan jointly with a Quebec team led by Aubry. Although the stopover site seems like a long way east for the birds to fly to from their Arctic breeding sites on Southampton Island in Nunavat, it is on the great circle route, the shortest path to Tierra del Fuego from the Maritimes. Because of the favourable winds at this time of the year, the route is also used by other fall migrants. If the knots refuel adequately in Mingan, they can fly nonstop to South America.

In 2007 and 2008, we were able to re-sight more than 1,000 birds that had been previously flagged in Tierra del Fuego, San Antonio Oeste, Maranhao, Delaware Bay, and Florida. These data will be used to estimate annual survival on northward versus southward migration, and between Delaware Bay and Mingan. In August 2008, in five small catches spaced throughout the month, we caught 112 knots. Our earliest catch that month included mostly females, which leave the Arctic soon after their eggs hatch, and some males that probably failed to breed or raise chicks. Almost all birds caught after August 7 were males. These males had likely raised chicks, since fathers stay about

Spawning horseshoe crabs were heavily overharvested as bait for the conch and eel fisheries, and this had a disastrous impact on red knots, which were unable to refuel properly

three weeks longer in the Arctic to brood the chicks at night and protect them from predators.

Juveniles also began appearing with the late males, and we counted many more young than in 2007. That year males, females, and juveniles had all arrived at the same time. We concluded that 2008 was a rare good breeding season. On October 3, Patricia Gonzalez telephoned me from the beach in San Antonio in Argentina to report an estimated 30 juveniles among some 400 red knots she was scanning with her team. The flock included one adult female seen in Mingan just 6 weeks previously. In the intervening weeks, the bird had migrated the 13,000 km to Patagonia.

This is the first time that a southbound knot observed departing from Canada has been detected in Argentina soon after arrival. Although San Antonio Oeste is a vital feeding ground for the birds to fuel up for their northbound flights to the Arctic, it also provides a brief stopover on the return flight to Rio Grande and Bahia Lomas in the Argentinian and Chilean parts of Tierra del Fuego, respectively. Thanks to financial support from Birdlife Netherlands through the Global Flyway Network, the Western Hemisphere Shorebird Reserve Network through the Manomet Bird Observatory in Massachusetts, and the stewardship provided by the Fundacion Inalafquen, this wetland has become extremely well monitored and was a centrepiece in international efforts to protect stopover sites. Since the San Antonio Oeste Interpretation Centre was constructed, it has transformed public education and awareness of just how critical wetlands are for conserving shorebirds like red knots. But sadly, the municipality of San Antonio Oeste, despite protests from local and international conservation groups, recently excavated a tidal swimming pool in the richest part of the knots' feeding habitat. Hopefully, our efforts will prevent further construction on the beaches and give the birds a chance to refuel there, as they have always done in the past.

When I met Patricia in 1995 I never imagined our shared dream of building a flyway-wide team together to advance red knot and wetland conservation across the countries would be so rewarding, connecting us all in this extraordinary way. ○

Below: A thin red knot at Delaware Bay searches for eggs among upturned horseshoe crabs. Knots ingest the eggs at high rates, converting them into fat and muscle as energy stores for onward migration and survival in the Arctic.

Inset, top: A knot captured in Rio Grande, Tierra del Fuego, is examined to estimate what percentage of red breeding plumage has been moulted just after flying 15,000 km from the Arctic. Birds in good condition tend to moult earlier.

Inset, bottom: Luis Benegas of the Virginia Choquintel Museum in Rio Grande has co-organized all international expeditions to Argentinian Tierra del Fuego since 1995.

Photos: Luis Benegas and captured knot, Allan Baker. Knot and horseshoe crabs, © Bill Dalton

Barcoding

life

DEMYSTIFYING THE PROJECT THAT AIMS TO CLASSIFY THE WORLD'S **32 MILLION SPECIES** USING ONLY A SHORT STRAND OF DNA
TEN ROM BIOLOGISTS REPORT

Introduction

By **BURTON K. LIM**, assistant curator of Mammalogy

Everyone can identify a cow or a daisy. But there are millions of organisms on earth that only an expert in a highly specialized field of study can pinpoint as a particular species. Now identification is about to get much easier for experts and, eventually, for anyone with an interest in or curiosity about nature. A new method called DNA barcoding is helping biologists to rapidly identify individual species, similar to the way a supermarket barcode quickly identifies a particular product. Championed by Dr. Paul Hebert at the Biodiversity Institute of Ontario at the University of Guelph, genetic barcoding, rather than scanning a series of bars, reads a short segment of DNA.

All life is coded by DNA—a double-stranded helix structure made from four nucleotide bases—adenine (A), thymine (T), cytosine (C), and guanine (G). The sequence in which A, T, C, and G are strung along the strand of DNA in organisms' cells ultimately determines the species.

The barcoding approach is poised to make identification of the earth's almost 2 million known species and discovery of the estimated 30 million species yet unknown a far less daunting task. Being able to quickly identify species has many useful applications. Mosquitoes, for example, transmit diseases such as malaria and West Nile virus.

Having fast and reliable identification helps medical workers to target the correct one of several thousand mosquito species and effectively fight these devastating human health problems throughout the world. Fungi provide another example. Among the yet-to-be-discovered species of this particularly poorly known group of organisms may be new yeasts that would improve food production or lead to new drugs to combat infections.

The scientific discipline called taxonomy—the study of categorizing and naming species—aims to classify our world's immense biodiversity. To meet the challenge of discovering and identifying species, resources to support this work and innovations in methodology must be stepped up—before these undiscovered species and their potential benefits are lost without a trace.

DNA barcoding is providing taxonomists with a new tool to speed things up. The ROM is one of the first of many institutions, including the Smithsonian, Harvard, and Academy of Natural Sciences in Philadelphia, to partner with the University of Guelph on the International Barcode of Life Initiative, a project that aims to build a reference database of genetic sequences for all species on earth. Since the project started in 2003, about 20 to 30 percent of species in familiar groups such as birds and mammals have been barcoded. Within the next five years, researchers will be able to quickly search this comprehensive catalogue to compare the barcode of a species they wish to identify with those of all species in the database. As of the beginning of 2009, there are already more than 50,000 species of organisms represented by more than 500,000 DNA barcodes of individual specimens. The ROM has contributed tens of thousands of tissue samples from our collections for this purpose.

The seven reports in this special feature summarize the research conducted by the ROM curators who are working at the forefront of molecular biology on this collaborative global project.

What is DNA Barcoding?

A primer on this new field of research

DNA barcoding is a way to identify species using a short sequence of DNA from a standard part of the cell's genome, or genetic material. This system is similar to a supermarket scanner that reads a pattern of lines of different thicknesses, called the Universal Product Code, to identify a specific item for purchase.

Traditionally, biologists identified biological species by looking at specific characteristics of its shape or form—called morphological features. Some organisms don't have obvious differences in their external appearance, such as colour variation or number of appendages, so a taxonomist was needed to analyze the smallest details for clues—things like minute cusp patterns on the teeth or fine structural details of the skull. If a specimen is damaged or is in an immature stage of development, even specialists may be unable to make an identification.

DNA barcoding is a new tool that will supplement taxonomic knowledge and enable non-experts in other fields of study, such as conservation biology, wildlife management, or endangered species protection, to make quick and cost-effective species identifications. The part of the gene used as the standard "barcode" for animal groups is a string of 648 base-pairs from a gene called cytochrome c oxidase 1 (CO1) found in the mitochondrion, or energy-producing part of the cell.

This particular region was selected because it had been well studied and was found to be variable enough to distinguish different species. CO1 has proved to be highly efficient in identifying birds, mammals, fish, amphibians, reptiles, butterflies, flies, and many other animal groups. Unfortunately, it is not an effective barcode region for plants. But botanists led by the Royal Botanic Gardens, Kew, in England are now close to identifying a combination of genes that will serve as the plant barcode region.

There are four main components to building a functional system for DNA barcoding.

1. Specimens that have already been identified using traditional taxonomy. Natural history museums, herbaria, zoos, aquaria, frozen tissue collections, seed banks, type-culture collections, and other repositories of biological materials are the treasure troves of life, containing tissue samples of known species from which genetic material can be extracted.
2. Molecular laboratory facilities. These are needed to extract, amplify, and sequence the DNA barcodes. Extraction involves breaking up tissue to release the DNA from cells. Amplification using a technique called the Polymerase Chain Reaction (PCR) makes numerous copies of the target gene to ensure there is enough genetic material for analysis. Sequencing involves using biochemical methods to determine in which order the nucleotide bases—adenine (A), guanine (G), cytosine (C), and thymine (T)—are strung along the strand of DNA. Central processing nodes throughout the world, such as the Canadian Centre for DNA Barcoding, have state-of-the-art equipment, which is available to researchers who do not have access to their own lab facilities.
3. A comprehensive database system. DNA sequences will be managed in a database system, a kind of reference library of identified species. The database will include associated information about the specimen, a photograph of the specimen, and map coordinates indicating where the specimen was found.
4. Sophisticated computational algorithms. Biologists use these programs to compare the newly generated sequence data with samples in the reference database to analyze barcodes. These results can be illustrated in the form of a branching tree, clustering similar sequences together and showing where

An Internal ID System for all Animals

The location of the DNA barcoding gene cytochrome c oxidase 1 (CO1) in the mitochondrion of the cell

in the tree of identified species the unknown samples belong or the next closest match. Unidentifiable specimens may be a species not yet added to the database, or a completely new species previously unknown to science.

JUDITH L. EGER, senior curator of Mammalogy, researches the systematics and biogeography of bats. Her current work on the tube-nosed bats of Southeast Asia has taken her on eight expeditions to Vietnam and China.

Barcoding Birds of the World

The All Birds Barcoding Initiative (ABBI) is an example of the efforts to coordinate participants throughout the world in efficiently sequencing the thousands of known bird species

When the concept of DNA barcoding was introduced it was greeted with considerable skepticism. It seemed that such a simple method could not possibly perform such a complex task.

To test its effectiveness and see how well the method performs at identifying species of vertebrates (animals with backbones), biologists carried out a number of feasibility studies, one of which involved the world's bird species. Birds were selected as a test case in 2005 because they have been studied extensively, and all known bird species in the world have been identified by evidence other than DNA. If DNA barcodes could also distinguish each of these known species, it would validate a rapid and cost-effective method of identifying birds—a task that has taken more than two and a half centuries using conventional methods.

I was appointed co-organizer of the All Birds Barcoding Initiative. Its inaugural meeting, held at the Museum of Comparative Zoology, Harvard University, in September 2005, was attended by 48 specialists from 23 countries, many of them representatives for major museum collections. ROM staff have been active in contributing DNA barcodes of species from our international bird collections, concentrating on the Nearctic (Canada, USA, and Mexico) and Neotropics (Central and South America).

Rather than show all the bases in the short sequence, my postdoctoral fellow Dr. Erika Tavares and I prefer to use just the differences in DNA between closely related sister species, such as the two goldeneyes shown here. To effectively sample variation within a species, ideally we would obtain sequences from at least five individuals from different parts of the bird's geographic range. This strategy has clearly shown that, as expected, variation among different species tends to be much higher than variation within a species. To date, ABBI participants have barcoded 14,335 bird specimens representing 2,567 species. The identity of these species has been confirmed, each with its unique barcode with clusters of similar sequences.

But in addition, 42 clusters have been discovered, each probably representing a species new to science. Current work with birds from the hyper diverse fauna in the Neotropics suggests that even more new species will be found there, since some barcode clusters differ markedly from one individual bird to another within what was previously thought to be one species. Once all the bird species in the world are sampled, the library of barcodes will be invaluable in the management and conservation of avian biodiversity on the planet.

ALLAN J. BAKER is senior curator of Ornithology, specializing in the evolution of birds.

Summary

All life is coded by DNA—a string of polypeptides made from only 4 bases—A, T, C, and G. The sequence in which A, T, C, and G occur along the string of DNA determines the species.

1. DNA is extracted from a tissue sample of the target specimen.

2. The CO1 gene, the "barcode" gene, is isolated and copied many times.

3. The copies for each species are sequenced, analyzed, and compared to the reference database to tell us which species it is.

4. The barcode sequence for the specimen is entered into the database along with the scientific name of the species, a photo of it, and GPS coordinates of where it was found.

Two Goldeneyes

Different mutations in the barcodes of two species of goldeneye diving ducks that uniquely identify them as *Bucephala islandica* and *B. clangula*

Photos: (goldeneyes) Courtesy Adrian Pingstone, Wikimedia Commons. Figures: Suz Bateson, Biodiversity Institute of Ontario

Glossary

Amplification
Making numerous copies of a fragment of DNA, usually using the Polymerase Chain Reaction (PCR) method, which uses several cycles of heating and cooling to accomplish exponential replication of the target sequence.

Barcoding
A genetic-based system designed to identify and discover species.

Biodiversity
The different species of organisms, characterized by variations in morphology, genetics, ecology, and behaviour.

CO1
The gene called cytochrome c oxidase subunit 1, the barcoding gene found in mitochondrial DNA.

Cryptic species
Two or more species that are indistinguishable by traditional morphological examination but are genetically distinct.

Revealing the Hidden Biodiversity of Amphibian and Non-Bird Reptilian Life

Barcoding has identified many cryptic species among what were thought to be common widespread ones, which has implications for their conservation status and for estimates of biodiversity

Scientists often encounter groups of animals that look like they belong to a single broadly distributed species. But analysis of their DNA barcodes frequently reveals that many of these creatures are genetically quite different from each other, and likely belong to separate species.

Here at the ROM, as part of a larger, ongoing research program, we have used DNA barcoding techniques to investigate questions about the processes that lead to speciation and to uncover hidden or cryptic species. Much of our focus in herpetology, the study of amphibians and reptiles, has been on Mexico and Vietnam, two of the most biologically diverse countries in the world. As part of his doctoral dissertation, Christopher Blair has been examining patterns of genetic divergence and speciation in a diverse group of Mexican geckos (*Phyllodactylus*) that seem to be restricted to rocky outcrops adjacent to streams and rivers. Genetic analysis using CO1 has revealed substantial previously unrecognized diversity within the group, leading to the assumption that several undocumented species exist throughout the threatened tropical dry forests of Mexico and Central America.

Photo: Courtesy © R.W. Murphy

Similar results were found on the peninsula of Baja California, with genetic analysis showing evidence for another unrecognized species of *Phyllodactylus* that awaits formal scientific description. Thus, using DNA barcoding techniques may help elucidate the suite of factors that contribute to neotropical biodiversity.

In Asia, it's the same story. The Asian whipping frog (*Polypedates leucomystax*) is generally considered a single widely distributed species commonly found in forests and cities throughout southern and Southeast Asia. Despite, or possibly because, they are ubiquitous, surprisingly little attention has been paid to these frogs. DNA barcoding has suggested that what was thought to be the single species may actually be eleven or more separate species. The perception of it as a widespread "junk" frog may lead to its being dismissed as not requiring protection. But such sweeping assessments may prove to be grievous errors given what barcoding has allowed us to learn.

ANDRE NGO, Ph.D., has research interests in the patterns of biodiversity and rates of speciation in reptiles and amphibians. His research focuses on the genetics of widespread species of amphibians in the tropical forests of Southeast Asia.

CHRISTOPHER BLAIR, Ph.D. candidate, has an interest in the systematics and molecular ecology of tropical organisms, particularly reptiles and amphibians. His current research is on the macro- and microgeographic patterns of genetic diversity in neotropical geckos.

BOB MURPHY is the senior curator of Herpetology at the ROM. His research focuses on the molecular evolution and conservation genetics of a wide variety of life forms, including viruses, mussels, insects, amphibians, and reptiles.

Molecules and Morphology: ROM Ichthyology and FishBOL

Barcoding has led to a better understanding of the limits and boundaries of traditional morphologically based taxonomy of goby fishes in the Pacific Ocean

Pygmy gobies, or *Trimma*, are small, colourful coral reef fishes found in the Indian and Pacific oceans from South Africa and the Red Sea in the west to Pitcairn Island in the east. Usually between 2 and 3 cm in length, these fishes often perch on coral or the sea floor, darting upwards to feed on prey in the water above them.

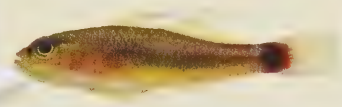
Fishes provide more than 15 percent of the animal protein to the global food supply, so it is critical to be able to distinguish one species of fish from another at all life stages, from eggs to adults. In the past, fishes were described using morphological characters, such as colour pattern, position of fins, number of fin rays, and scale counts. More recently, genetic sequencing has also been used to identify species of fish, although not in isolation. Now DNA barcoding is proving to be suitable for species identification in the management of fisheries and aquatic ecosystem conservation.

The ROM Ichthyology section has been collecting fish tissues from Ontario, South America, and the Indo-Pacific for the past 20 years and was approached to participate in the launch of the Fish Barcode of Life (FishBOL) project in 2005. Our unique collection of *Trimma* tissues from the Indo-Pacific, in particular, provides a good opportunity to test whether or not barcoding can distinguish among the many closely related species in this genus. Currently there are 60 described species of *Trimma*, with another

Coral reef fishes

Barcoding is uncovering new species of gobies

Trimma benjamini from Palau appears to be genetically distinct from morphologically similar populations in Australia and New Caledonia.



Trimma tevegae was once considered to be a morphologically variable species throughout its range. It now appears that there are three genetically distinct species from Palau alone.

Photo: Courtesy © R. Winterbottom

approximately 30 species awaiting description. To date, 31 of the species have been barcoded and analyzed. While many of the results support the validity of the described species, there were also a few surprises.

The FishBOL's general guideline for what constitutes a species is that variation in DNA within a species should be less than 5 percent and variation between species should be around 10 percent. *Trimma flammeum* and *T. macrophthalma* fit the model beautifully. *T. flammeum* of the western Indian Ocean and *T. macrophthalma* of the western Pacific look very similar except for differences in the colour intensity of two spots on the pectoral fin base. BOL analysis shows variation within each species at less than 1.5 percent but the variation between the two species is 9.1 percent, clearly showing that the two are distinct species. But some *Trimma* species have larger than expected variation between different populations. The minimum difference between populations of *T. benjamini* from Palau compared with Australia and New Caledonia populations, for example, is 6.7 percent. In contrast, the maximum variation within the Palau population alone is just 0.5 percent, meaning that the Palau fish could represent a new species distinct from the others, even though, morphologically, we have found no differences between the populations.

Even more complicated is the example of *Trimma tevegae*, which shows a variation in morphology and colour pattern throughout its geographic range from Japan to the Great Barrier Reef, west to the Maldives and into the Red Sea. Presently, the ROM has tissue samples only from Palau, but barcoding results indicate that in this region alone there are three different species. The variation among these three potential species ranges from 15 to 20 percent. If there are three species in Palau, then it is quite likely that multiple species exist in other localities as well, which could explain the range of morphological variation.

Although the Barcode of Life Project for fishes has proven to be a valuable tool in answering some of our questions about species diversity, it has raised numerous other issues, making it clear that further research is needed to delineate the molecular and morphological species boundaries.

MARY BURRIDGE is assistant curator and **MARGARET ZUR** is a technician in the Ichthyology section of the ROM's Department of Natural History.

Barcoding Fungi

New laboratory protocols must be developed when the standard gene region fails to work effectively, as is the case with fungi

Sequences from the gene region CO1 have been proving effective for distinguishing between species in many groups of animals. So, it was proposed that such sequences might also be useful for distinguishing between species of fungi, plants, algae, and protists, thus making CO1 a universal marker for DNA barcoding all earth's eukaryotic species—those organisms whose cells have a nucleus, in contrast to prokaryotes, such as bacteria, whose DNA is not concentrated in a nucleus. This proposal was tested in the ROM's mycology laboratory. Since fungi are simple in form, and species identification is often challenging, DNA-based identification methods would be quite useful.

Fungal forms include single-celled organisms, such as baker's and brewer's yeasts, which were domesticated by early humans to produce bread and wine. Another morphologically simple fungus of benefit to humans is *Penicillium chrysogenum*, the source of the antibiotic penicillin. Mushrooms are more structurally complex forms of fungi, many of them a delicious source of food.

But despite their ubiquity in nature, not to mention the many essential roles they play in terrestrial environments and the many ways they interact with human health and wealth, fungi are cryptic and often overlooked species. It is estimated that the 80,000 or so fungal species recognized to date represent only 5 to 10 percent of the total fungal diversity. Most new species will be found in unexplored regions or habitats and many will be microscopic. Given these circumstances, we wondered whether CO1 could speed up the discovery of these species and help with their identification, as has been the case in other life forms.

Unfortunately, we've found that the answer is no. A recent study indicated that CO1 alone identified only 67 percent of 70 species in the *Penicillium* subgenus *Penicillium*. Another marker, beta-tubulin (*Ben*A), scored better, identifying 81 percent. In another case study, CO1 and two other markers were tested to see if they could identify six species of oyster mushrooms. CO1 distinguished only two species, while all six were resolved by each of the other two markers—called translation elongation factor 1-alpha (*Tef*1) and internal transcribed spacer of ribosomal RNA gene (ITS-rDNA). Both of these genes are taken from a cell's nucleus, whereas CO1 is taken from the mitochondria. Another problem with CO1 (and other mitochondrial genes) is that in most fungal species, the gene is

DNA
Deoxyribonucleic acid, the building block of life. It stores genetic information that dictates the development and functioning in all living organisms.

Eukaryote
Most known organisms, including animals, plants, fungi, and protists, are categorized as eukaryotes. They are characterized by complex cells that have DNA stored in the nucleus.

Extraction
A biochemical method of isolating DNA from the cells within a tissue sample.

High throughput
Automated robotic system that processes large volumes of DNA sequences.

Mitochondria
Energy producing organelles found in the cells of an organism. The barcoding gene is located within the mitochondria.

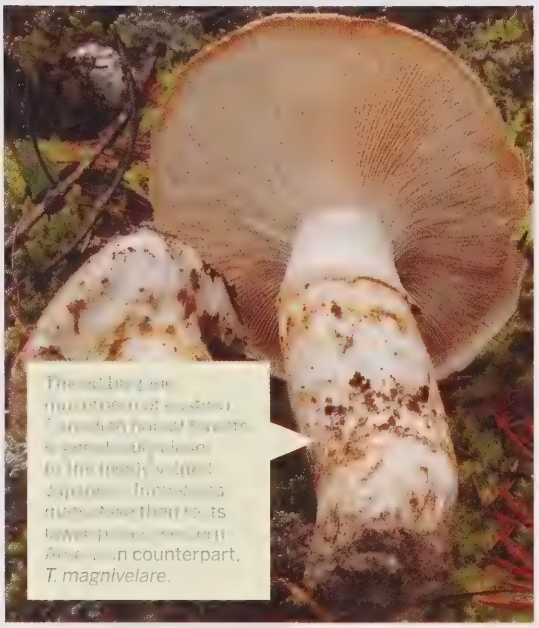
Nucleotide bases
The four molecules found in DNA—adenine (A), thymine (T), cytosine (C), and guanine (G).

Sequencing
A technique that reads the order in which the nucleotide bases are found along a strand of DNA taken from a tissue sample.

Systematics
The study of the evolutionary relationships of organisms.

Taxonomy
The naming and classifying of species.

Tree
Branching network that groups specimens together for graphically representing the relationships among species.



[illegible] n counterpart, *T. magnivelare*.

interrupted with large "introns"—sections of "junk" DNA that do not appear to have a function. Why these occur in genomes is still unclear, but they make amplification and sequencing of fungi genes from the mitochondria impractical using our current techniques.

To date, ITS-rDNA is the preferred molecule for identifying fungal species, although on its own it isn't useful in all groups, and a combination of alternative barcodes looks more promising. Several recent studies have shown that rDNA sequences can identify fungi from DNA extracted directly from environmental samples such as soil, water, or air. We tested this method of bulk environmental sampling in our laboratory using forest soil from southern Ontario and it enabled us to discover many novel fungal groups. By using rDNA barcodes we have shown that the pine mushroom of eastern Canadian boreal forests is distinct from that in western Canada (*Tricholoma magnivelare*) and very similar to the highly priced Eurasian *T. matsutake*.

These studies suggest that the nuclear genes tested, including ITS-rDNA, *Tef*1, and *Ben*A, perform more efficiently than CO1 for distinguishing among fungal species. But there is as yet no single short genomic fragment that is satisfactory for barcoding all fungal species. Using multiple markers for DNA barcoding is likely to be the most successful approach in identifying fungi.

JEAN-MARC MONCALVO, senior curator of Mycology, and his research group use molecular systematic methods to study the biological diversity, phylogeographic relationships, taxonomy, and ecology of fungi, particularly gilled mushrooms. Current research focuses on relationships between eastern North American and eastern Asian forest mushrooms.

Barcoding Canadian Freshwater Fishes

Barcoding the freshwater fishes of Canada demonstrates the practical application of the method in a well-known but difficult-to-identify group of species

The North American freshwater fish fauna is one of the world's best known. It numbers approximately 1,200 species, 17 percent, or 203, of which occur in Canada. And while we have a good grasp on their scientific classification, few biologists can reliably identify all fishes down to the species level without considerable training in fish anatomy. There are seven species of redhorse suckers, for example, that fisheries biologists often either misidentify or cannot identify. Juvenile redhorse suckers are particularly challenging, and positive identifications require specimens to be sacrificed and sent to one of a handful of experts.

Because some redhorse species are threatened with extinction, this method poses a problem. Fishes in early life stages, such as eggs, larvae, and juveniles, are next to impossible even for experts to identify. Yet, law enforcement officers are often required to identify species based only on parts of the organism, such as fillets, and ecologists need to identify partly digested prey found in stomachs. These are typical real-life questions that DNA barcoding can effectively and efficiently solve with a small tissue sample, such as a fin clipping or piece of muscle.

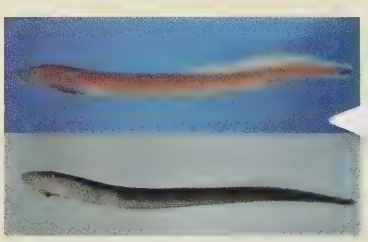
The University of Laval is leading a study with seven other institutions* to test the usefulness of barcoding for identifying Canadian freshwater fishes. There are 190 species in the reference database so far. The ROM contributed 30 percent of the tissues—861 specimens representing 127 species—which had been acquired over a 16-year period. The barcode study successfully identified 93 percent of Canada's freshwater fishes.

Even so, there was considerable genetic diversity within some species, and barcodes were unable to discriminate between

Look-a-likes and barcode results

Most freshwater fishes could be correctly identified using barcoding

Two species of juvenile redhorse suckers [illegible] rse (top), which s threathened, and the greater redhorse (bottom), which is not



The DNA barcodes of the northern brook lamprey (top) and the silver lamprey are nearly identical (less than 0.5 % sequence divergence), although they are considered different species based on morphology.

Photos: (mushroom) Courtesy © Dr. Bryn Dentinger, Postdoctoral Fellow, Royal Ontario Museum and University of Toronto; (fishes) Courtesy © E. Holm

* University of Guelph, Royal Ontario Museum, Department of Fisheries and Oceans, University of British Columbia, Ministère des Ressources naturelles et de la faune du Québec, University of New Brunswick, and Dalhousie University.

several others. Analysis of the results suggested that there were small but significant differences between the eastern and western populations of six species, and large differences between eastern and western populations of three species—brook stickleback, blacknose dace, and redfin pickerel. Further study is needed to determine if they should be recognized as distinct species. In contrast, there was no difference in the DNA barcodes of six species of ciscoes (genus *Coregonus*), confirming the results of an earlier study suggesting that they may all be one species. Similarly, the lack of genetic difference between the parasitic silver lamprey and the non-parasitic northern brook lamprey suggests that the two could be lumped together as a single species.

While most Canadian freshwater fishes can be identified using barcodes, the study highlighted several taxonomic problems that require further work.

ERLING HOLM is an assistant curator and manager of the ROM's collection of fishes. He has an interest in the species of Ontario and South America, particularly those that are threatened with extinction, and is a recognized authority in the identification of Ontario's fishes.

The Future of DNA Barcoding

Barcoding technology is advancing rapidly, making it easier and quicker to identify species, as shown in an environmental assessment of small mammals in Suriname

To gather DNA sequences for the ultimate reference library of hundreds of millions of records—documenting the tens of millions of organisms of life on earth—requires two things: being at the forefront of high throughput methodology, a system to handle massive quantities of molecular data, and keeping abreast of the latest technological advances.

The logical places to start the barcode project on a large scale are the world's universities and museums, such as the ROM, which have been the repositories of natural history collections for many years. Tissue samples in these institutions are typically stored in liquid nitrogen containers at -196°C or ultra-cold freezers at -80°C to minimize enzymatic breakdown over time.

Sequencing these existing samples is a good starting point, but many more samples need to be collected *de novo* to achieve a comprehensive database. State-of-the-art laboratories and database management systems are also needed to process and organize all these specimens and the several terabytes of associated information. The Canadian Centre for DNA Barcoding at the University of Guelph was the first large-scale facility for DNA barcoding in the world when it was set up in 2006. It is fully automated with robotic technology for high throughput processing based on 96 samples per plate for DNA extraction, gene amplification, and nucleotide sequencing. In contrast, typical lab methods involve manual processing of individual samples at each step of the process.

To facilitate high-volume processing, similarly formatted and specially treated archival filter-paper cards enable quick blotting, or blood sampling, of specimens under field conditions for immediate use in the lab. The DNA is stabilized for long-term preservation right in the field for future extraction and amplification. This saves time by eliminating the sub-sampling step at the lab that would entail retrieving each specimen from cold storage before starting the DNA isolation process.

We used this method to complete an environmental assessment of small mammal biodiversity in Suriname in a timely manner. It took about one month to get results that previously would have taken more than a year to complete. For ecological projects, the archival cards are a fast and convenient method to confirm species identification in certain situations: collecting physical specimens may not be required in well-studied areas or may not be possible with endangered species. The researcher can simply mail the cards to the lab and get a list of species sent back without having to leave the field.

There are plans in the works to make it even easier—with a futuristic hand-held DNA barcoder for analyzing and identifying species. The device would assist both the researcher documenting and discovering organism diversity, and the backyard naturalist exploring the outdoors. The barcoding device will not only automatically identify any plant or animal encountered on a hike through the park by simply taking a sample of a leaf, feather, or hair, but will also link with the web to provide more information about the identified creature. It'll be like having a library of nature field guides at your fingertips. It might even be possible to combine the DNA barcoder with your cell phone, mp3 player, and GPS. Beam me up, Scotty?! ○

BURTON K. LIM, assistant curator of Mammalogy, studies the biodiversity of mammals with an emphasis on the evolution of bats. His latest research investigates mammalian biogeography in South America and why there is such high species richness, particularly in the Amazon region.

ID at your fingertips

The future of species identification

A prototype of a futuristic hand-held DNA barcoder for analyzing and identifying species.

Photo: © Biodiversity Institute of Ontario (BIO)

Life in the Time of the

Dead Sea Scrolls

ONE OF THE GREATEST ARCHAEOLOGICAL FINDS OF THE 20TH CENTURY OFFERS AN UNFILTERED GLIMPSE INTO LIFE IN JUDEA AND GALILEE 2,000 YEARS AGO

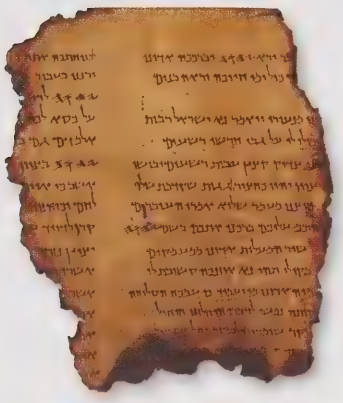
BASED ON A DESCRIPTION BY **STEVEN SPENCER**

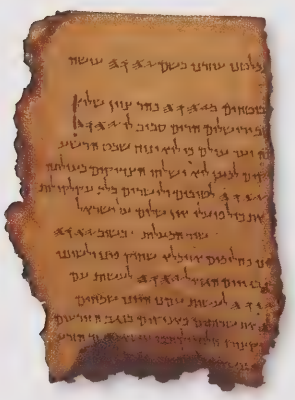
Above: Fragment of the "Book of War" scroll, 20–50 CE.

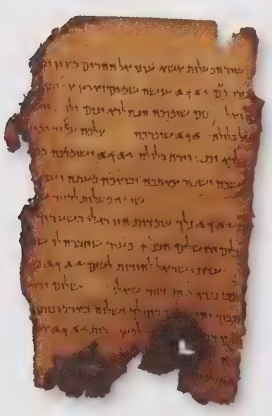
Two thousand years ago, the people of Judea and Galilee were locked in a simmering conflict with the Roman authorities that ruled their lands. It was a conflict that would lead to two rebellions, one in the first century CE and one in the second. Both ended in disaster for the Jewish people, and initiated a period of exile and loss that would last for 20 centuries

The Dead Sea Scrolls lay in these caves along the shore of the Dead Sea for 2,000 years until being discovered by a Bedouin looking for an errant goat in the 1940s.

At the same time, and in the same lands, walked a man from the town of Nazareth, a preacher of a kind, who was perceived in different ways—as a reformer, a healer, and a leader, among other things. Fearing him as a catalyst for revolt, the Romans executed him. Most of his followers would come to believe that he was, in some sense, the deity himself in human guise.







Above: Fragments of the "Psalms" scroll, 1–50 CE. Discovered in cave 11 in 1956.

In June, selections of the most important and the only original texts that still exist from that time, the Dead Sea Scrolls, will be coming to the ROM. Discovered in the 1940s and 1950s, the scrolls opened a clear new window on our knowledge of life at the turn of the millennium 2,000 years ago.

Before that there were only ancient texts copied and re-copied over and over, through the centuries. There was Philo, a Jewish man of first-century Alexandria, for example, who wrote books about his religion, in part to explain it to his Greek-speaking contemporaries. More famously there was Josephus, a first-century Judean who wrote several books about his people, including an account of the First Revolt, which resulted in the destruction of the Temple in Jerusalem in 70 CE.

These texts tell us about beliefs and events dating from the period in which post-Temple Judaism and Christianity took form. They are critical to our understanding of the establishment of these two religions.

But none of these texts exists in its original state. We have copies of copies, many times over. Very few extant examples of these texts date from before the 8th century CE; most others date from centuries later. What opportunity—and temptation!—there must have been for subtle alteration, discreet omission, and careful addition, to suit a political or theological agenda of a particular time. How can we be sure that someone did not tamper with the text?

In truth, there was no way to tell, unless an obvious stylistic aberration revealed a re-working— until the Dead Sea Scrolls were discovered. For 2,000 years they lay hidden in caves, left by people who never returned for them. That the scrolls survived at all is astonishing. Even more astounding, they date from precisely the years in which early Judaism and Christianity were beginning to take form. The scrolls include all but one of the books of the Hebrew Bible, offering an unprecedented opportunity to compare them to much later extant examples. Just as amazing, though, the scrolls provide evidence of decidedly unconventional Jewish beliefs and practices at that time, offering a completely unlooked-for window into the diversity and internal stresses of a people under siege. The world that saw the birth of the two religions was far more fluid and varied than was previously thought, characterized by the coexistence of several communities of religious interpretation, all claiming ancient Israel as their heritage.

The tale of the discovery and retrieval of the scrolls is a fascinating one, beginning with a Bedouin looking for an errant goat. The discovery led to clandestine digging by Bedouin tribesmen, dangerous forays by archaeologists and scholars during the war of 1948, the surprisingly pecuniary tendencies of a bishop, quiet arrangements with shadowy merchants and dealers in antiquities, frantic fundraising in North America and elsewhere, and finally the gradual gathering of the scrolls in a single place in Jerusalem. It is a miracle of tenacity, generosity, and detective work that nearly all the known parchment scrolls today inhabit a single institution in Jerusalem, the Israel Museum.

It took some time before the significance of the scrolls was realized, and an even longer time before their content was fully known. At first there was suspicion that they were forgeries, but scholars soon accepted their genuineness, and antiquity. Some of the scrolls were published relatively quickly after they had been deciphered, in the 1950s and 1960s. But the contents of Cave 4, representing 40 percent of the finds, were entrusted to an international team of scholars led by the Dominican Father Roland de Vaux. For various reasons, including a vexatious "secrecy rule" imposed on the team, little of this text was published for many years, sparking various theories about what the team was hiding from the world. Finally, in the 1990s, publication began in earnest. In the end there was no secret to hide, just hesitation, inefficiency, and lack of funding. Today, all the scrolls have been deciphered and published, a monumentally difficult task, considering that most are in a highly fragmentary, fragile state. Now, the major challenge facing these manuscripts is their preservation.

In the 1950s Roland de Vaux also led the archaeological excavation of Qumran, an ancient settlement close to the caves that housed the scrolls. About this community, too, the outside world eagerly awaited information, but when de Vaux died in 1971 he had not yet published a final report. Some of his field notes have been edited and published since, but not all, even today. Given that the purpose of the Qumran settlement and its relationship to the scroll caves are still mysterious and debatable, the absence of these archaeological data is regrettable. The

Photos: Courtesy of the Israel Antiquities Authority

Photo: © Duby Tal, Albatross

Above: Aerial view of Qumran, the archaeological site closest to the caves where the scrolls were discovered.

Discovery of the Dead Sea Scrolls was one of the greatest archaeological events of the 20th century

Qumran site has been variously described as the home of a Jewish sect, a monastic community, a place where the scrolls were written, a pottery manufactory, a fort, and a villa.

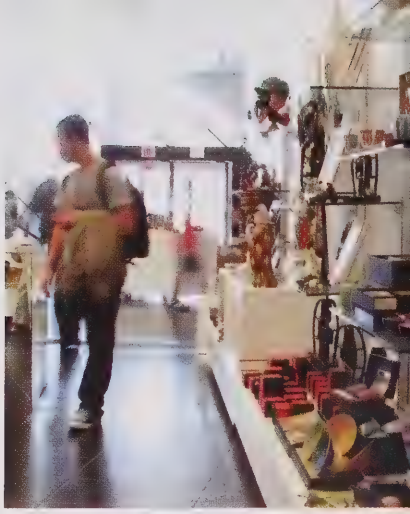
To immerse yourself in the past is the only way truly to understand it. What was the world like at the time the scrolls were written and hidden—especially in Judea itself, with its own long history, and its subservience at the time to Rome? What was Judaism like in the days before the destruction of the Temple? What did the Hebrew Bible look like at that time? To answer these questions, you review the political, military, and cultural history of the eastern Mediterranean, with a glance at world history for greater context. You turn to Judea, following the return of the Judeans from the Babylonian exile around 538 BCE. You marvel at their survival under successive imperial regimes and under the persistent, seductive influence of Greek culture. You look at Jerusalem and the Temple in the century or two before 70 CE. You see actual components of the Temple, redolent with historical and religious associations. And, so that you are not biased by the wealth and diversity of Jerusalem and the overpowering presence and magnificence of the Temple, you turn to other places in Judea, to see how other Judeans and Galileans lived, worshipped, and died. You visit Qumran, the peculiar settlement that existed near the caves of the scrolls, and ponder its relationship to the manuscripts.

This is a time when the Bible is not yet fixed, and the religious life of Judea is varied. The powerful priesthood ensconced in the Temple and the ascetic, seemingly isolationist community described in the scrolls are worlds apart, though both derive from a common fund of scripture. You feel stress and division in the land, driven in part by the disdain that the Romans feel for certain tenets and customs of the Judean faith. Soon these tensions will erupt in violence. The scrolls will be hidden, and never reclaimed. Perhaps those who hid them took part in the resistance. If so, that would explain why they never returned, for the Romans conducted a ruthless campaign of retribution. They destroyed Qumran, but they never found the scrolls. And so they remained, concealed from history, a strange and mysterious time capsule directed, as it turned out, to us. o

To learn more about the Anne Tanenbaum Dead Sea Scrolls lecture series, see page 44. For details of how to obtain ROM Member tickets, see page 42.

Eco-Chic: How to Look and Feel Fabulous

The ROM Museum Store offers a number of eco-options



Keira Knightly, Gwyneth Paltrow, Madonna, and George Clooney have been spotted wearing them. Natalie Portman and Pamela Anderson have plans to produce them. Environmentally friendly fashions have come a long way since the stereotypical back-to-the-land burlap number. Eco-fashion has become, well, fashionable. Both LA and New York have produced special green shows during their prestigious Fashion Weeks, with eco-creations by such top designers as Halston and Oscar de la Renta.

When shopping for environmentally friendly fashions—or any household products—consider the following:

Fibre content. Choose textiles that are grown organically—cotton, wool, linen, hemp. Fibres that can be composted are also smart options: think "naturally derived manmade fibres" like wood pulp, bamboo, soy, and corn.

Longevity. How long will the item last. If you throw it out after one season, it may not be as eco-friendly as you thought.

Laundering. This is one of the greatest burdens our clothing puts on the environment. Best choice: items that can be washed in cold water and line dried.

Locally made. Items that are produced locally reduce the green house emissions produced by shipping and support local economies.

Now you can look chic and still be responsible to the earth and the garment makers.

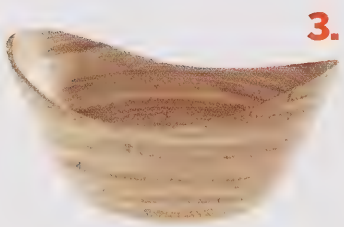
1.

1. KNOW
The KNOW line, which stands for Knowingly Nurture Our World, offers fashionable eco-friendly shirts. At the ROM, you'll find Know Happiness, a faux long-sleeve tee with lettuce-edge short sleeves, and Know Earth, a classic-fit long-sleeve tee promoting the importance of knowledge. **$69.99.** These tees are incredibly soft.
Why we love it! Made from a bamboo/organic cotton blend with eco-friendly dyes and embellishments.

2.

2. NIGHT OWL PAPER GOODS
This unique eco-friendly line offers handmade stationery like flat birch wood cards with envelopes. **$6.99 each.**
Why we love it! Made from sustainably harvested birch wood and 100% recycled paper. The manufacturing process requires little power and no water

3.

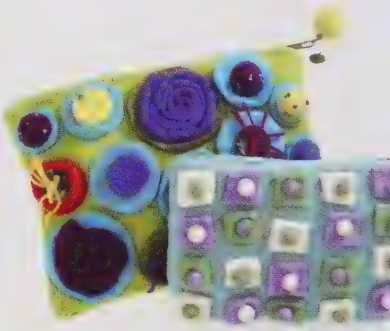


3. BAMBOO
This handcrafted collection of bamboo food-safe serving pieces features various earth-toned stains and finishes. Pictured bowl: **$16.99.**
Why we love it! Bamboo, one of the greenest materials around, is an incredibly fast-growing and versatile grass, not a tree.

4.

4. RISING TIDE
This line of one-of-a-kind bags and coin purses features eye-catching textures, bold and rich colours, and unique designs. **$9.99 to $49.99**
Why we love it! Made from 100% sheep's wool using an ancient hand-art technique of felting that produces a seamless and long-lasting product. All Rising Tide products are made with recycled and cruelty-free textiles and ensure a fair wage and people-friendly production process.

Store hours: 10 am to 6:30 pm, except Friday 10 am to 9:30 pm.
Kids Store: Monday to Thursday 10 am to 4 pm, Saturday and Sunday 10 am to 5:30 pm.



Fishing for Solutions

How Canadian chefs are keeping endangered species off the menu

BY JAMES CHATTO

I never had the chance to taste blue pike, once a highly prized and delicious mainstay of the Great Lakes fisheries. The last one was caught in Lake Erie in 1971. Atlantic cod was a commonplace of my fish-and-chips-loving youth—but we all know what happened to them. As individuals, we humans are capable of glorious and imaginative acts of heroism; en masse we have a tendency, in our greedy, grubby little way, to drive other forms of life to extinction.

Over-fishing is nothing new. The archaeological record provides umpteen plausible examples, from the giant clams of the Red Sea 125,000 years ago to Peruvian shellfish 3,000 years ago, to English river fish circa 1,000 CE. But we've got much better at it in the last half-century. Doomsday scenarios from around the world all point to empty seas before the year 2050.

We must try to prove them wrong. Perhaps you remember the campaign a few years ago that successfully persuaded many Canadians to stop eating Chilean sea bass. It was effective because the message was simple and because a carrot was offered along with the shtick. Chefs came up with alternative dishes that were delectable as well as righteous, and everyone—even the fishmongers—ended up happy.

Different initiatives are rolling these days, but again it's the chefs and restaurateurs who are taking responsibility. Hard-working Patrick McMurray, owner of Starfish in Toronto, cuts deals directly with fishermen. "We get sustainable wild pickerel, silver bass, and sturgeon from Purdy's on Lake Huron," he explains, "and Eric Wagner, a lobsterman on P.E.I., sends me the lobster and fish he catches. As a fisherman, he understands that every sea creature has its natural season. I pay him three times what he normally gets from selling to a middleman and it still costs me less."

Other chefs rely on organizations such as **Ocean Wise**™, a highly responsible global program created by the Vancouver Aquarium that monitors what fish and seafood we should and shouldn't be eating from one month to the next. The Ocean Wise symbol beside a dish on a menu guarantees that the fish in question is not endangered and is harvested in a sustainable way. There are those, for instance, who won't eat Asian shrimp because of the ecologically disastrous aquaculture involved, but diners at the ROM's c5 Restaurant/Lounge can feel confident ordering chef Ted Corrado's poached B.C. spot shrimp, the delicate, juicy flesh offset by perfectly textured grains of barley and earthily sweet heirloom carrots.

Ocean Wise

Below: Blue pike, a tasty Great Lakes fish, became extinct in 1971.

We may not have time to read up on the latest facts, but we can at least read a menu and choose to do the right thing. Supporting enlightened chefs sets in motion a process that ends up influencing fishmongers and ultimately fishing fleets. It may seem like a drop in the ocean, but with governments busy elsewhere, it's actually our best hope—before the other fish and seafood we love go the way of Lake Erie's blue pike. ○

JAMES CHATTO is a Toronto-based food writer, *Toronto Life*'s food columnist, and editor of *harry* magazine.

Photos: Seafood, ©iStockphoto.com/4x6. Plate, ©iStockphoto.com/galdzer

Watching the Garden Grow

Studying Liza's Garden will help biologists document the changing biodiversity of green roof habitats

Green roofs date back thousands of years—to long before the famous hanging gardens of Babylon in 500 BCE. In recent decades they have become an expanding frontier on the urban landscape. From an aesthetic perspective, they soften the harsh lines of the urban skyline and provide shade on rooftops. But green roofs also have an environmental benefit. When these previously barren spaces are populated with living plants, they break up what is known as the urban heat island—heat that is absorbed and trapped where there is a concentration of asphalt, roads, and buildings. They also help with stormwater retention—reducing the quantity of water that drains into a city's sewage system.

Toronto has had green roofs for 30 years or more. But the trend took a leap forward in 1998 when the Fairmont Royal York retrofit its roof to support a garden, and Mountain Equipment Coop incorporated a green roof into the design of its new building. Today, the City of Toronto's Green Roof Planning team, an active body that among other things coordinates the city's green roof incentive program, estimates that in downtown Toronto alone there are now well in excess of 100 green roofs and the number is on the rise.

Liza's Garden, installed in 2008 on the roof of the ROM's original 1914 building, is one of Toronto's newest green roofs. The 855-square-metre (9,500-square-foot) installation named in honour of Elizabeth Samuel—a long-time

THE DESIGN

1 One of their innovations was to encourage movement from the presence of the wind by angling each of the roof's nine trees to catch any breezes. The six garden beds are planted in such a way that the succession of flowers and leaves provides a continuous variety of texture and colour throughout the seasons.

2 Another novel approach was to intersperse the planting beds with a series of reflecting pools of recycled blue glass that reduce the garden's overall weight because they weigh less than soil. They also collect rainwater and snow that attract birds and other creatures. Strings of lights provide night-time appeal as well as day-time perches for visiting birds.

Weight restrictions and awkward access mean that Liza's Garden can be seen but not walked in. It can be viewed by patrons of c5 Restaurant/Lounge or by joining one of the Department of Museum Volunteer's docent tours held on Saturday mornings.

ROM benefactor, former chair of the Board of Trustees, and avid gardener—was designed and built by PLANT Architects Inc. in association with consultants Gardens in the Sky.

As with most existing buildings, the original ROM's 95-year-old asphalt and skylight roof is not designed to bear the weight of a substantial garden. A soil depth of just 5 to 8 cm (2 to 3 inches) is all the roof can support. Most plants, even those that grow on bedrock outcrops and limestone pavements, require 15 cm (6 inches) of soil, so planting choices were limited. By planting atop existing column supports, the architects were able to include nine deep-rooted trees, but the rest of the roof is planted with a combination of shallow-rooted herbs.

When it was unveiled on June 18, 2008, Liza's Garden appeared to be nothing more than a sea of brown burlap amidst pools of blue glass and aluminum frames. But thousands of plugs of tiny plants formed alternating grids in each of the six garden beds. The beds are planted with many species of stonecrops, hens and chicks, horsetails, and chives, interspersed with young, mostly native, trees, including serviceberry, yellow wood, trembling aspen, and staghorn sumac. Thanks to the hot temperatures and ample rain last summer, by August the plants and trees were well established and beginning to expand.

Every gardener knows that freshly planted ground is ripe territory for colonization by "volunteer species" that come in on their own. Their identity and frequency of occurrence is of interest to biologists seeking to understand the ecology of different habitats. As green roofs have grown in popularity and have been recognized for their contributions to the urban landscape, there has been a rising interest in documenting the biodiversity and measuring the ecological functions of these constructed environments.

Above:

Left:

Photo: Deborah Metsger. Rendering: PLANT Architects Inc.

As a newly planted roof, Liza's Garden affords a good opportunity to document the transformation of a rooftop into an architecturally and biologically interesting green space. Photographs have been taken at least once a month since the start of construction to chart the changes over time.

In keeping with the ROM's research and education mandate, Liza's Garden as soon as it was planted was made available for use as a living laboratory to professor Mart Gross and his students of the University of Toronto's Department of Ecology and Evolutionary Biology. It is one of 13 green roofs in downtown Toronto included in their green roof research project. The project's objective is to assess biodiversity on green roofs by documenting which species of insects, arthropods, and plants colonize them; the occurrence of pollinating insects in these gardens; and their use by resident and migratory birds.

Preliminary results from Dr. Gross's study indicate that green roofs support as much or more pollinating- and non-pollinating insect and arthropod biodiversity as nearby habitats on the ground. And though rooftops do not seem to be much used by fall migratory birds, they are commonly frequented by resident urban species, including European starling, house sparrow, rock dove, American robin, ring-billed gull, and American crow.

As for plants, Gross's team found that green roofs are readily colonized by perennial plants dispersed by wind and animals. In rooftop gardens that had been established for many years, the biodiversity is greater and the composition of the rooftop flora substantially different from when they were planted. As the most recently planted garden in the study, Liza's Garden has provided data documenting which plant species are first to arrive. Within six weeks of planting, more than 18 new species had colonized the garden.

All of these preliminary results suggest that green roofs do indeed contribute to the biodiversity of the urban ecosystem and are viable urban habitats.

As spring approaches and Liza's Garden comes out of dormancy, plants and trees will flower and fruit for the first time. The brown burlap will shink from view as plants grow and spread. Will different birds visit this season? Will the insect fauna change as the garden matures? We eagerly anticipate watching for these changes and answering these questions as Liza's garden enters its second growing season. ○

DEBORAH A. METSGER is assistant curator of Botany in the ROM's Department of Natural History

Liza's Garden was funded in Elizabeth Samuel's honour by her former board colleagues, her family, friends, members of the Department of Museum Volunteers, and other generous donations made in her memory. Additional support provided by the TD Friends of the Environment Foundation, the City of Toronto Green Roof Incentive Program, and an anonymous donor.

For more about green roofs in Toronto go to **www.toronto.ca/greenroofs/index.htm**

Space Rocks

Most meteorites date from the very beginning of our solar system over 4.5 billion years ago and enter the Earth's atmosphere at 17 kilometres per second or faster. That's like going from Toronto to New York city in 30 seconds or less.

WHO AM I?
Do you know which species of butterfly this is?

ANSWER
It's the goliath birdwing butterfly, the second largest in the world.

These three princesses learned about food chains and royalty, not to mention friendship, at the ROM's Summer Club.

EXCLUSIVE FREE EVENT

ROM Explorers' Club

Explorers' Club Members can enjoy a fun-filled day of themed crafts and activities that explore the natural world and the creatures that live in it.

Saturday, May 23, 2009 Drop by anytime between 10 am and 2 pm but please allow a minimum of one hour to complete all crafts and activities. Free. Parental guidance and registration are required. Please register the kids only. Explorers' Club Members Only. Watch for your e-vite to confirm times and places or go to rom.on.ca/whatson.

Saturday Morning Club

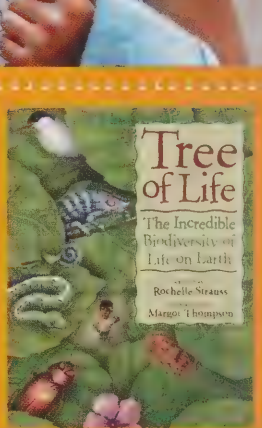
Paint a Masterpiece, Build an Empire, Explore the World . . . All Before Lunch

Want to know the ROM inside and out? Join the club! Saturday Morning Club, that is. Every fall, winter and spring, fun and fantastic programs are offered for SMCers (aged 5–14). For a listing of sessions, visit rom.on.ca and follow the Programs link to ROMkids.

Generously supported by the Philip and Berthe Morton Foundation.

BOOKS!

Our Planet Earth
A brightly illustrated introduction to earth sciences and geography. By Giovanni Caviezel. Illustrations by Roberta Pagnoni. Barron's Educational Series Inc. $8.95

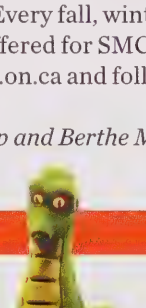


Tree of Life
Nominated for the 2005 Green Earth Book Award, this volume covers life sciences and the classification of living things. Ages 8 and up. By Rochelle Strauss. Illustrations by Margot Thompson. Kids Can Press. $19.95

Fun Facts:

Gordo!

Gordo, the ROM's mascot, is named after our *Barosaurus*, the largest mounted dinosaur in Canada. Gordo was named after Dr. Gordon Edmond who traded a hadrosaur for this giant specimen in 1962. The word "gordo" also means "fat" in Spanish, which makes sense, don't you think?



Hieroglyphs

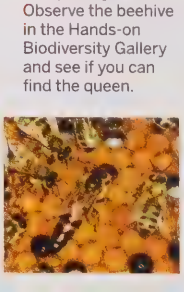
The mysterious hieroglyphs on the canopic jar in the Discovery Gallery are actually fake. The jar itself is more than 1,500 years old, but the writing was added less than 200 years ago. Our canopic jar once contained the lungs of a mummy.

Stick Bugs

All the stick bugs in the Hands-on Biodiversity Gallery are female. Come take a look at all the babies.

The Queen

Queen bees can live for up to 5 years. Observe the beehive in the Hands-on Biodiversity Gallery and see if you can find the queen.



Photos: Night sky, Moon ©iStockphoto.com/aarrkk; Princesses, Joyanna Sampson; Stick bug ©iStockphoto.com/Captainflash; Bees ©iS

FOR OUR members

The latest offers and information

NEWS / EVENTS / SUPPORT / **PROGRAMS** / TRAVEL / SPONSORSHIP

ROM GOVERNORS MESSAGE

The Greening of the ROM

New environmental initiatives take us closer to our goal of being an advocate for science

As I watched my daughter taking care to write on both sides of her notepaper, I suddenly flashed back to a scene from years before: watching my mother doing the exact same thing. While my daughter's decision was based on "being green," my mother's motivation was pure economics. I find myself somewhere in the middle—practising my mother's habit of saving while learning new "acts of green" from my kids.

"Being green" has become a catch-all phrase to describe everything from buying environmentally friendly cleaning products to debating the merits of alternative energy. Whether you engage with our climate crisis on a consumer basis, on an intellectual level, or as an activist, it really doesn't matter. What matters is that you engage.

That's what this issue of *ROM* Magazine is about: exploring the Museum's environmental initiatives, starting with the magazine in your hands. It's our first issue to be printed on recycled paper. And the polybag it's delivered in: organic. Inside, you'll read about projects such as the Schad Gallery of Biodiversity, which opens this spring.

Rich with specimens as diverse as a school of sharks and a live colony of leaf-cutter ants, the new gallery features multimedia elements for interactively exploring the complex relationship between species, habitats, and the environmental issues that threaten their survival. But what will really engage visitors is the programming. The Earth Rangers Studio, a state-of-the-art space for lectures, workshops, and live animal shows, is wired for broadcast capability. Just imagine—a ROM curator could be in the field in the South Pacific and give a virtual lesson to students at the Museum, half a world away.

As with many ROM initiatives, the Schad Gallery was made possible by the generosity of private donors. Robert Schad, founder and chairman of the partnership-driven environmental charity, Earth Rangers, gave $12 million toward this gallery, its programming, and related scientific research by ROM curators. This incredible gift allows the Museum to take one more step in our commitment to being an advocate for science in the understanding of nature.

When the Schad Gallery opens in late spring, I'll be bringing my mother and daughter. I'm sure it will quickly become one of their favourites.

PS: The Earth Rangers will be performing during March Break 2009. See the enclosed "Let's ROM" booklet for details.

DR. MARIE BOUNTROGIANNI
PRESIDENT AND EXECUTIVE DIRECTOR
OF THE ROM GOVERNORS

ROM BOARDS

PATRONS The Right Honourable Michäelle Jean, C.C. C.M.M. C.D. Governor General of Canada; The Hon. David C. Onley, O. Ont, Lieutenant Governor of Ontario / **BOARD OF TRUSTEES** Salvatore Badali **(Chair)**, Ann Dumyn **(Vice-Chair)**, Elyse Allan, Susan E. Crocker, Andrew Faas, Hamlin Grange, Paul Haggis, Christine Karcza, Won J. Kim, Elsie Lo, Barbara Milstein, Hari Panday, Marilyn Pilkington, Colin Saldanha, Barbara Stymiest, Carol Wilding, Judith Wolfson / *Ex-officio* David Naylor, Jack Petch, William Thorsell / **BOARD OF GOVERNORS** James Temerty, C.M. **(Chairman)**, Linda Hasenfratz **(Vice-Chair)** / **GOVERNORS** Shreyas Ajmera, Dr. Marie Bountrogianni, Rudolph Bratty, G. Raymond Chang, Jack Cockwell, Michael Detlefsen, W. Robert Farquharson, Gwen Harvey, Jennifer Ivey Bannock, Michael Lee-Chin, Donald R. Lindsay, Rebecca MacDonald, James W. McCutcheon, Dr. Jack M. Mintz, Peter Oliver, Robert E. Pierce, Elizabeth Schad, Simona Shnaider, (Joseph) Joey M. Tanenbaum, C.M., Rita Tsang, Harriet Walker, V. Prem Watsa, Richard S. Wernham, Alfred G. Wirth *Ex-officio* Joan Randall, M. Joan Thompson, William Thorsell, Salvatore Badali / **HERITAGE GOVERNORS** Joan Randall **(Co-chair)**, Joan Thompson **(Co-chair)**, Robert D. Brown, Robert Gillespie, Ned Goodman, Kenneth W. Harrigan, Patricia Harris, Hon. Hal Jackman, Thomas Kierans, Elsie Lo, Susanne Loewen, Stephens B. Lowden, Brenda McCutcheon, Jack McOuat, Frank Milligan, Dixie-Anne Montgomery, Frank Potter, Wendy Rebanks, Flavia Redelmeier, John A. Rhind, Lynton R. Wilson / **SENIOR STAFF** William Thorsell **(Director and Chief Executive Officer)**, Glenn Dobbin **(Deputy Director, Operations, and Secretary to the Board of Trustees)**, Mark Engstrom **(Deputy Director, Collections and Research)**, Dr. Marie Bountrogianni **(President and Executive Director, Office of the ROM Governors)**.

SNEAK PREVIEWS

ROM MEMBERS ARE INVITED TO A SNEAK PREVIEW OF THE SCHAD GALLERY OF BIODIVERSITY. GO TO **ROM.ON.CA/WHATSON** FOR DETAILS.

MEMBER INFORMATION

MUSEUM MEMBERSHIP
Individual: 1 year $90; 2 years $160
Family/Dual: 1 year $139; 2 years $250
Non-Resident: 1 year $95; 2 years $170
Student: $50
Explorers: $15 (in addition to ROM Membership)
Curators' Circle: $175
Museum Circle: $300
Director's Circle: $600
Young Patrons' Circle: Single $600; Dual $1,000
Royal Patrons' Circle: $1,500+

TELEPHONE NUMBERS
Membership Services: 416.586.5700
Switchboard: 416.586.5549
Bell Relay Service: 711
School Groups: 416.586.5801
Museum Volunteers: 416.586.5513
ROM Museum Store: 416.586.5766
c5 Restaurant/Lounge Members Reservation Line: 416.586.8095
Donations: 416.586.5660

Attention Members: Your privacy is important to us. The Royal Ontario Museum (ROM) and the ROM Governors (the ROM's charitable foundation) share a special relationship and you may receive additional information from each. If you do not wish to receive it, contact membership@rom.on.ca or or call 416.586.5700.

Occasionally, we make our list of supporters available to other carefully screened curatorial organizations and selected groups that may be of interest to you. Please understand that by allowing us to exchange your name, you are helping us support the ROM's education and research mandates. If you prefer not to have your name exchanged, please contact us at membership@rom.on.ca or at 416.586.5700.

The ROM Membership Department operates a telemarketing office. Should you prefer not to be contacted by telephone, please call us at the above listed e-mail address or phone number and we will have your number removed from our list.

Membership/Bookings:
416.586.5700
rom.on.ca/members

NEWS & PROGRAMS

How to Get Members' Tickets for Dead Sea Scrolls

When can I get my Dead Sea Scrolls tickets?
Tickets for the exhibition will be available to Members in advance of the general public:
- Beginning **March 2** for RPC and YPC Members
- Starting **March 16** for Director's Circle and Museum Circle Members
- Starting **April 1** for ROM Members at all other levels
- Tickets go on sale to the general public on **May 1**

How many free tickets am I entitled to?
- **RPC, YPC, Director's Circle, and Museum Circle Members:** Each Membership is entitled to 2 adult tickets, 4 children's tickets (17 and under), and 2 guest tickets free of charge.
- **Family/Dual and Non-Resident Members** are entitled to 2 adult tickets and 4 children's tickets.
- **Student and Individual Members** are entitled to 1 adult ticket.
- **Life Members** are entitled to 1 adult ticket and 2 guest tickets.
- After an initial visit, any Member can purchase an additional ticket for just $6 each.

How do I obtain my tickets?
You can visit the Members' Admission Desk in person to pick up tickets or go on the ROM's website at **rom.on.ca/members.php** and click The Dead Sea Scrolls ticket link to book your tickets. You can print them off your computer at home. Note that tickets are dated and timed so know your preferred date and time when booking.

For further details, call **416.586.5700**.

ROM Gives Passes to Families at SickKids

The ROM and The Hospital for Sick Children in Toronto have partnered to provide 120 families with free tickets to the Museum in 2009. The year-long passes are distributed through the Child Life Program at SickKids. For details, contact Matet Nebres at 416.813.6380. These passes build on the Museum's Community Access Network, or ROM CAN, an innovative program that provides free Museum tickets to communities and individuals who may not otherwise visit the Museum.
This collaborative initiative is made possible by the generous support of the ROM Governors.

ROM Friends Events

Friends of the Canadian Collections
Canadian Treasures from the Rare Book Collections of the ROM *For FCC Members Only*
ROM librarian Arthur Smith gives a virtual guided tour through Canadian gems ranging from the late 1500s to the late 20th century.
Monday, March 23, 2009, 4 to 6 pm.
Free. Registration is required. Call 416.586.5700.

Friends of South Asia
Art for Art's Sake: Exploring Contemporary South Asian Art
Join us for a fascinating look at contemporary South Asian art, which has in recent decades attracted international attention and garnered record market prices. ROM curator Dr. Deepali Dewan and speakers Haema Sivanesan (executive director of South Asian Visual Arts Collective) and Ali Adil Khan (founder and owner of the South Asian Gallery of Art) explore this expanding new style of art.
Wednesday, May 13, 2009, 6:30 to 8 pm
Signy and Cléophée Eaton Theatre
FSA Members: Free
Public and ROM Members: $25
Registration is required. Call 416.586.5700.

Friends of the Medieval Studies Society
4th Annual ROM Medieval Symposium
An event not to be missed by anyone interested in Medieval culture. Ten experts from the fields of archaeology, history, culture, and art will speak on various aspects of the Medieval world, from the late classical world to the Renaissance.
Saturday, March 28, 2009, 9 am to 5 pm
Signy and Cléophée Eaton Theatre

For more information or to purchase tickets, call 416.586.5797, e-mail programs@rom.on.ca, or go to rom.on.ca/whats on.

Free Day at AGO for ROM Members

The ROM has struck a deal with the Art Gallery of Ontario for a free reciprocal day for Members. Watch your e-mail or go to **rom.on.ca/whatson** for details.

University of Toronto to Acquire 90 Queen's Park

The ROM and the University of Toronto have reached an agreement that will provide U of T with a location for academic use in the heart of its St. George campus and support the Museum's capital goals for Renaissance ROM.
U of T has agreed to purchase the site of the former McLaughlin Planetarium for $22 million. Prior to closing a number of conditions must be met, including consent from the City of Toronto for severance of the land.

Trustee Election Update

In the December issue of *ROM* Magazine we called for nominations for one of the Museum's membership-elected Trustee positions. Nominations for this position were accepted by the Office of the Secretary to the Board until January 31, 2009, at 12 noon. One candidate was duly nominated. In accordance with ROM Board policy, Danuta Buczynski has been acclaimed to a membership elected Trustee position on the ROM Board, effective July 1, 2009, to June 30, 2012.

As a 22-year volunteer with the ROM, Danuta Buczynski has been involved with general and specialized tours, and served as president of both the DMV and ROM Reproductions. The ROM extends its congratulations and looks forward to working with her on the Board.

EXPRESS ENTRY FOR MEMBERS Bring your membership card and a second piece of identification.

For a complete listing of the ROM's programs, go to **rom.on.ca/whatson**

December 17, 2008

A Sparkling Debut

EVENTS

The Teck Suite of Galleries: Earth's Treasures Unveiled

On December 17, 2008, the ROM treated a group of more than 300 special guests to an exclusive preview of the newest permanent gallery spaces, the Teck Suite of Galleries: Earth's Treasures. Guests mingled among 2,300 specimens from the Museum's exceptional collections of minerals, gems, meteorites, and rocks.

In her welcoming remarks, Dr. Marie Bountrogianni, president and executive director of the ROM Governors, expressed the Museum's sincere thanks to all those who helped to create this suite of galleries. "The story of the new Teck Suite of Galleries is one of innovation, a passion for education, and above all a true spirit of collaboration," she said. "All the partners—Teck, Vale Inco Limited, the Canadian Mining Hall of Fame, and the ROM—came together with one goal in mind: to transform this Museum into a premier educator of earth sciences."

Encompassing the Vale Inco Limited Gallery of Minerals, the Gallery of Gems and Gold, and the Canadian Mining Hall of Fame Gallery, the Teck Suite on the second floor of the Weston Family Wing consists of 6,900 square feet of displays and more than 40 interactive touch-screen stations and compelling video exhibits.

The suite is named for the mining company Teck, whose generous contribution to the Renaissance ROM campaign is the largest corporate gift in the Museum's history.

Top (left to right): Dianne Henderson, Loretta Lazaro, Jean Read **Middle (left to right):** Dr. Marie Bountrogianni, president and executive director of the ROM Governors; Hon. Donna Cansfield, Minister of Natural Resources; Eric Myers, Keith Myers, Jack McOuat, Leslie Myers, Vodrie McOuat; Jalynn Bennett and Bill James **Bottom:** Gary and Matthew Percy

Photos: Jeff Speed

SUPPORT

Royal Patrons' Circle

RPC MEMBERS SEE MORE OF THE MUSEUM WITH A BEHIND-THE-SCENES TOUR

On November 19, 2008, members of the Royal Patrons' Circle (RPC) braved winter's first snow storm to get a closer look at the ROM's collections. RPC is an annual giving program that combines ROM Membership with philanthropy, and part of that experience is the opportunity to take a more intimate look behind the scenes at some of the ROM's many treasures, objects that are not on display to the public.

Some 55 RPC members and guests touring four areas of the Louise Hawley Stone Curatorial Centre—entomology, Egyptian storage, European decorative arts, and textiles & costume—were shown artifacts ranging from kimonos and European silks to butterflies and a mummy case—even a mummified cat. The tours are a great way to learn about the Museum's current research projects from experts and, at the reception following the tour, to mingle, enjoy refreshments, and speak with curatorial staff.

Established 25 years ago, the RPC continues to enrich the ROM's collections, programming, and international research. Gifts to the Royal Patrons' Circle begin at $1,500 annually with the option of monthly giving. For details, call 416.586.5842.

Young Patrons' Circle

BOOK THE DATE FOR PROM IV: OCEAN DRIVE

The *National Post* has dubbed it "the best party of the year." With themes like Solid Gold (2007) and Crystallized (2008), PROM, an annual event hosted by the Museum's Young Patrons' Circle (YPC), is not just an opportunity to see and be seen, but a great way to support the Museum.

YPC is Canada's first and largest museum membership group catering to young, urban professionals, a philanthropic group whose members aim to support the goals of the Museum while having fun with their peers. From its inception in fall 2005, membership has grown to more than 400.

Last year's glitzy PROM hosted 1,000 guests, and this year's is expected to be equally dazzling. Book the date now—Saturday, March 28, 2009— for PROM IV: Ocean Drive, whose theme was inspired by the live coral reef in the soon-to-open Schad Gallery of Biodiversity. Toronto cool will meet Miami heat at this breezy South Beach scene. Under tall palms and white cabanas, enjoy cocktails and entertainment: drummers and Miami-sound-pumping DJs JoJo Flores and Mateo will set the feverish pace. The night begins with a sizzling dinner by celebrity chef Mark McEwan, his Food Network show aptly titled *The Heat*. For tickets, or information on how to join the Young Patrons' Circle, call 416.586.8003 or contact us at **ypc@rom.on.ca**.

Clockwise from top left: Bruce Kuwabara and Gareth Seltzer; Gabrielle Totesau, Carolyn Schroeder, Ilana Nadler, and Katie Quigley; Luc Vincent, Monika Schnarre and Glen Dixon; PROM partygoers; Kyle Riabko

ANNE TANENBAUM LECTURE SERIES

Dead Sea Scrolls

Accompanying the ROM's *Dead Sea Scrolls* exhibition opening this June is a special lecture series featuring some of the world's top experts.

Price per lecture: $28, online $26; ROM members and students $25, online $23. For details or to register, go to **rom.on.ca/programs** and click What's On Calendar or call 416.586.5797.

All lectures will be held in the Signy and Cléophée Eaton Theatre or the Samuel Hall Currelly Gallery twice per night—at 6 pm and 8 pm, unless otherwise noted.

Tuesday, June 23
The Impact of the Dead Sea Scrolls on the Bible
Dr. Eugene Ulrich, John A. O'Brien Professor of Hebrew Scriptures, University of Notre Dame, and Chief Editor of the Biblical Qumran Scrolls.

Thursday, July 2
The Archaeology of Khirbet Qumran: Recent Excavation Discoveries
Yuval Peleg, Israel Antiquities Authority District Archaeologist for the Jordan Valley.

Thursday, July 16
The Stories of the Toronto Dead Sea Scrolls
Dr. Marty Abegg, Ben Zion Wacholder Professor of Dead Sea Scroll Studies, Religious Studies Department, Trinity Western University, Langley, British Columbia, and Co-Director of the Dead Sea Scrolls Institute.

Thursday, July 23
Jerusalem in the Dead Sea Scrolls
Dr. Dan Bahat, former district archaeologist for Jerusalem, and currently Associate Professor, University of St. Michael's College, University of Toronto.

Wednesday, September 16
The Historical Problem of the Essenes
Dr. Steve Mason, Professor, Department of History, and Canada Research Chair in Greco-Roman Cultural Interaction, York University, Toronto.

Thursday, September 24
The Archaeology of Qumran and the Dead Sea Scrolls
Dr. Jodi Magness, Kenan Distinguished Professor for Teaching Excellence in Early Judaism, Department of Religious Studies, University of North Carolina, Chapel Hill.

Photos: PROM, Tom Sandler

Above: Fragment of the "Book of War" scroll. 20–50 CE.

Thursday, October 15
Women in the Dead Sea Scrolls
Dr. Eileen Schuller, Professor, Department of Religious Studies, McMaster University, Hamilton, Ontario.

Thursday, October 29
Israel at the Time of the Dead Sea Scrolls
Dr. Lawrence Schiffman, Edelman Professor of Hebrew and Judaic Studies, and Chair of the Skirball Department of Hebrew and Judaic Studies, New York University.

Thursday, November 5
Rabbis and Romans at Sepphoris: Ornament of All Galilee
Dr. Eric Meyers, Bernice and Morton Lerner Professor of Jewish Studies, and Director, Center for Jewish Studies, Duke University, North Carolina. Past president, American Schools of Oriental Research.

Wednesday, November 11
The Conservation and Preservation of the Dead Sea Scrolls
Pnina Shor, Head of the Department for the Treatment and Conservation of Artifacts, Israel Antiquities Authority.

Sunday, November 15
The Scribes of Qumran
Dr. Emanuel Tov, J. L. Magnes Professor of Bible, Hebrew University, Jerusalem, and Editor-in-Chief, Dead Sea Scrolls Publication Project.
Lecture at 5 pm and 6:30 pm

Thursday, December 3
Returning to Sinai: Revelation at Qumran
Dr. Hindy Najman, director, Centre for Jewish Studies, and associate professor, Department and Centre for the Study of Religion, University of Toronto.

Tuesday, December 15
Jewish and Christian Origins as Revealed by the Dead Sea Scrolls
Risa Levitt Kohn, Director, Jewish Studies Program, and professor, Religious Studies Department, San Diego State University.

Photos: Scroll fragment, Courtesy of the Israel Antiquities Authority. Gaudí's Batlo House, Allison Fisher. Gaudí's Sagrada Familia Cathedral and Casa Mila rooftop, Courtesy Spain Info. Train, ©iStockphoto.com/rest

TRAVEL

Barcelona: Style Capital

FROM ICONIC ARCHITECTURE TO RELAXED RAMBLING, BARCELONA'S ÉLAN IS MUCH IN EVIDENCE

One of the world's most dynamic and stylish cities, Barcelona is a place of contrasts—narrow cobbled lanes lead onto expansive boulevards; secluded, tranquil squares and extensive parks are juxtaposed with an exciting waterfront and a vibrant artistic culture. Through the heart of the city, Las Ramblas, a tree-shaded walkway laid out in the 1770s, pulses with musicians, flower stalls, and mime artists.

But perhaps what Barcelona is best known for is its style and design. The Spanish have made their painters—Picasso, Miró, Dalí—national heroes. A maze of narrow lanes, Barri Gòtic, one of the best-preserved medieval centres in Europe, is home to the Museu Picasso. Spanish architects are no less revered, and Barcelona is one of the best cities in Europe to study the evolution of architecture from Roman times to the 21st century. Mont Montjuïc, overlooking the historic port, houses an eclectic collection of museums, art galleries, and gardens, including The Joan Miró Foundation, the site of the 1992 Olympics, and Mies van der Rohe's German Pavilion—one of the most influential buildings of the 20th century. L'Eixample (New Expansion) is recognized as the world's greatest living museum of Art Nouveau architecture. And there are numerous buildings by Antoni Gaudí, the most famous of the Modernista architects. His fluid, organic creations like La Sagrada Família are among Barcelona's most iconic monuments.

If you like to learn while you travel, ROMTravel offers Barcelona: Style Capital, a 10-night tour of Barcelona and nearby regions, guided by art historians, who will be on-hand to explain the city's mysteries and legends. You'll also visit the Costa Brava and Figueres, home to the Teatro-Museo Dalí, spend a few days exploring vineyards, ancient hill towns, and bodegas (wine cellars) in the renowned La Rioja region of northern Spain, and travel to Bilbao, where Frank Gehry's Guggenheim Museum is the star attraction.

October 15 to 26, 2009
$5,995 (International flights not included; internal flights included)
For further information, contact ROMtravel at 416.586.8034, e-mail travel@rom.on.ca or visit the website rom.on.ca/programs/rom_travel.

Upcoming Trips

Fashionable Secrets of Paris and Normandy: May 22 to 31, 2009

China: Temples, Tombs & Towers: October 12 to 30, 2009

Indochine: Laos, Cambodia & Vietnam: January 19 to February 6, 2010

Sicily: Journey Through the Ages: April 2010

Berlin: May 2010

Arctic Northwest Passage: July 2010

Churchill, Manitoba: The Polar Bear Express: October 2010

Chicago: October 2010

SPONSORSHIP

THANKS TO THE SUPPORT OF PRIVATE COMPANIES AND INDIVIDUAL FOUNDATIONS, THE ROM IS ABLE TO OFFER MORE AND BETTER PROGRAMS TO ALL VISITORS

The Philip & Berthe Morton Foundation Helps Kids Explore

Long an advocate of engaging young families, the ROM has been running kids programs since the mid 1930s. Saturday Morning Club, a perennial favourite, was established in 1940 and for almost 70 years has been offering a place where creative and inquisitive kids can explore, create, and learn.

Thanks to the generous support of the Philip & Berthe Morton Foundation, kids aged 5 to 14 can explore their world during eight Saturdays of educational adventures like creating masterpieces in clay, discovering what fossils reveal about climate change, dressing like Egyptians, and learning about the wonders of the ancient world. The program is so popular that many participants become regulars—some have even been inspired by the experience to choose careers as archaeologists, paleontologists, artists, and other museum professionals.

The Philip & Berthe Morton Foundation has been supporting the ROM since 1991. Committed to furthering the cause of education, the foundation shares the ROM's passion for providing quality programming for children. Its support of Saturday Morning Club enables kids to learn about the wider world and discover the joys of curiosity, cultural diversity, hands-on exploration, and wonder.

For a listing of Saturday Morning Club sessions and registration information, visit rom.on.ca and follow the Programs link to "ROMkids."

Sun Life Financial Makes the ROM More Accessible with Half-Price Friday Nights

Accessibility is part of the ROM's mandate. The Museum is committed to providing access to its extensive collections to everyone, regardless of financial capability. Nine years ago, in an effort to remove the financial barrier to Museum admission, the ROM launched its Half-Price Friday Nights program, offering visitors an opportunity to enjoy the Museum at a greatly reduced price.

Sun Life Financial is a leading international financial services organization providing a diverse range of protection and wealth accumulation products and services to individuals and corporate customers. As sponsor of the ROM's Friday Nights program, they are helping to ensure that families of limited economic means have the opportunity to see the ROM's impressive permanent collections of natural history and world cultures as well as special exhibitions. As part of their Making the Arts More Accessible program, Sun Life also supports the Museum + Arts Pass program, which provides passes for free admission to local cultural venues, including the ROM. The passes will soon be available at all 99 branches of the Toronto Public Library.

Every Friday between 4:30 and 9 pm, ROM admission is $11 for adults, $9.50 for seniors and students with ID, and $7.50 for children.

Sun Life Financial

TELUS: Making Students' Futures Bright

School isn't the only place where kids learn. Every year, 150,000 Ontario students participate in educational programs at the ROM on topics like dinosaurs, patterns in nature, early Egyptian civilization, life in Medieval times, rocks and minerals, and more. It's not just a fun day out of the classroom. Hands-on learning at the ROM enhances the school curriculum and provides opportunities for kids to experience real scientific specimens and historical artifacts in an intriguing way.

As a new supporter of the ROM's 80-year-strong School Visits Program, TELUS is helping the Museum to offer schoolchildren this unforgettable experience. We hear so often that they remember it for a lifetime. As a leading national telecommunications company, TELUS connects 11.5 million customers every year. As a leading corporate citizen, the company is committed to building a corporate culture of giving, improving the quality of life in our communities. Thanks to their support of the School Visits Bursary Program through the TELUS Toronto Community Board, TELUS is helping thousands of students make the connection with world cultures and natural history through individualized self-guided visits, ROM teacher-guided gallery lessons, and interactive lab lessons. Launched in 2004, the program offers youth from at-risk communities a chance to participate free of charge in an interactive lesson with a ROM educator.

TELUS

Photo: Jovanna Scorsone

SOUTH KOREA
FINE CRAFT CULTURAL TOUR
SEPTEMBER 18 – OCTOBER 1, 2009

The Canadian Crafts Federation, provincial craft councils & partner organizations proudly present a unique 14 day Cultural Tour of South Korea.

This tour is a once-in-a-lifetime opportunity to travel with fellow Canadians interested in fine craft and cultural experiences. The tour highlight is the **Cheongju International Craft Biennale**, where Canada is the 2009 guest country. Fine craft from Canada, South Korea and 50 other nations will be assembled in the largest event of its kind in the world. The tour also features Changdeokgung Palace, National Folk Museum, Han River Cruise, Yongmunsa Temple, Korean Craft Council, Bukchon Hanok Village walking tour, Insadong gallery district, Icheon Ceramic Village, Korean Craft Museum, Cheongju Artists Village, studio visits, street markets and shopping, traditional and modern Korean cuisine, as well as the Biennale opening ceremony.

Prices range from $3,907 to $4,415.
Tour packages are based on double occupancy and include air, hotel, select meals and taxes.

For information and reservations contact:
www.mimiholidays.com/packages/CICB_2009.pdf
Joyce Lui at Mimi Holidays Inc.
info@mimiholidays.com or 1-866-918-4080

Optional post-tour extensions include a traditional hanok (historic house) experience in Korea, or travel to Japan, Thailand, Singapore, or China.

www.canadiancraftsfederation.ca www.cheongjubiennale.or.kr

Canadian Crafts Federation | Fédération canadienne des métiers d'art | 2009 청주국제공예비엔날레 Cheongju International Craft Biennale 2009 | Korea Sparkling | Mimi Holidays Inc.

Nut Cracker

These guinea pig relatives help South America's rainforests grow

BY BURTON K. LIM AND DEBORAH A. METSGER

See this agouti specimen in the upcoming Schad Gallery of Biodiversity's Tropical Forest Ecosystem.

A rodent related to the guinea pig, the agouti looks more like a huge rat without a tail. The red-rumped agouti, pictured here with a brazil nut, is native to South America. It and other agouti species are the most important seed dispersers of the Brazil nut tree.

A seed eater, the red-rumped agouti is also a scatterhoarder—it caches large quantities of seeds throughout the forest as a hedge against meager food resources in the future. With its sharp front teeth it chisels open the tough woody Brazil nut fruit, which, at up to 2 kg, can weigh almost half as much as the agouti. But inside is a bonanza of nutrition: each fruit contains up to 24 seeds.

Those that are not immediately consumed are buried up to 100 metres away. This is of great benefit for the growth of new Brazil nut trees. Seeds that remain inside fruits will eventually rot whereas those buried by agoutis often germinate and grow before the animal gets back to them.

Unlike most mammals, agoutis are diurnal—active during the day. A social group of agoutis typically consists of a monogamous pair and their offspring. These playful rodents can sometimes be seen chasing each other in the forest, oblivious to intruders in their tropical paradise. o

BURTON K. LIM is assistant curator of Mammalogy and **DEBORAH A. METSGER** is assistant curator of Botany, both in the ROM's Department of Natural History.

Natural Newfoundland and Legendary Labrador

• ST. JOHN'S • CAPE SPEAR NATIONAL HISTORIC SITE • NATURE CRUISE WITH WHALE WATCHING • TERRA NOVA NATIONAL PARK
• GROS MORNE NATIONAL PARK UNESCO WORLD HERITAGE SITE • L'ANSE AUX MEADOWS UNESCO WORLD HERITAGE SITE • LABRADOR • CORNER BROOK • TWILLINGATE

DOOR TO DOOR

$3,999* *Land and air per person*

12 Days, 18 Meals • Departs July 31, 2009

Other departure dates available

Newfoundland Labrador
CANADA

COLLETTE VACATIONS

To book or for more information visit your local travel agency or call

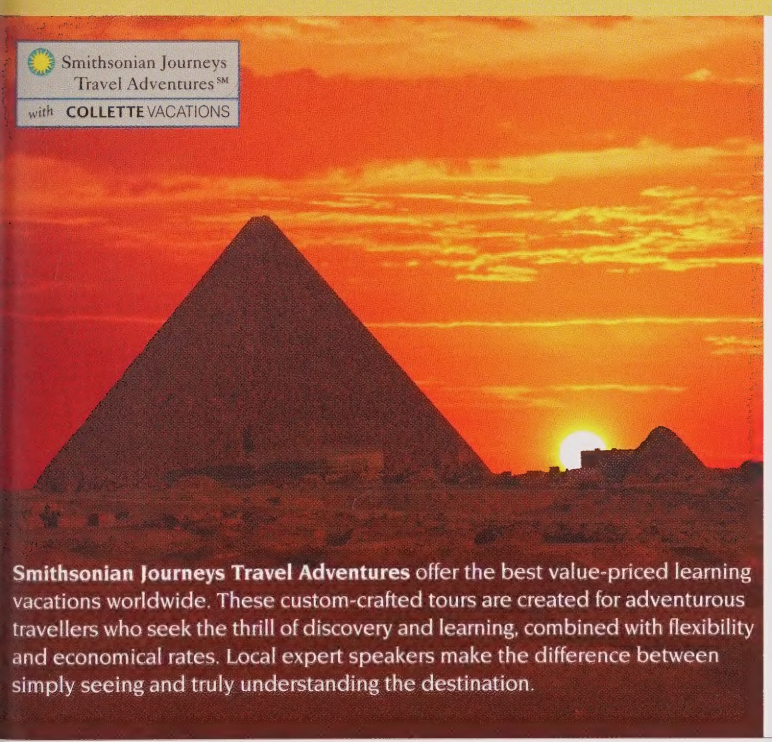
1-800-468-5955

**Based on double occupancy. Includes round trip air from Toronto, hotel transfers, taxes and fees and door to door transfers within 100km of Toronto, Ottawa, Halifax, Winnipeg, Calgary, Edmonton, Vancouver and Victoria airports. Taxes and fees are subject to increase until paid in full. Air rates and availability are valid at time of print and subject to increase until paid in full. Call for other rates and gateways.*

Promotion Code: C428-AX1-918

Splendours of The Nile

• CAIRO • PYRAMIDS • MEMPHIS • SAKKARA • LUXOR • VALLEY OF THE KINGS AND QUEENS • DELUXE 4-NIGHT NILE RIVER CRUISE • ASWAN



Smithsonian Journeys Travel Adventures offer the best value-priced learning vacations worldwide. These custom-crafted tours are created for adventurous travellers who seek the thrill of discovery and learning, combined with flexibility and economical rates. Local expert speakers make the difference between simply seeing and truly understanding the destination.

DOOR TO DOOR

$4,529* *Land and air per person*

12 Days, 22 Meals • Departs October 7, 2009

Other departure dates available

EGYPT
Nothing compares!

COLLETTE VACATIONS

To book or for more information visit your local travel agency or call

1-800-468-5955

**Based on double occupancy. Includes round trip air from Toronto, inter-air flights, hotel transfers, taxes and fuel surcharge and door to door transfers within 100km of Toronto, Ottawa, Halifax, Winnipeg, Calgary, Edmonton, Vancouver and Victoria airports. Taxes and fuel surcharge are subject to increase until paid in full. Air rates and availability are valid at time of print and subject to increase until paid in full. Call for other rates and gateways.*

Promotion Code: C427-AX1-918

Heffel's

Providing Unparalleled Customer Service

EMILY CARR, *A Forest Clearing*
oil on paper laid down on board, circa 1935, 23 x 34 5/8 inches
ESTIMATE: $125,000 ~ 175,000 **To be offered in our Spring Live Auction of Fine Canadian Art ~ June 17, 2009**

Heffel's offers customized services to individuals, corporations and estates. We provide written appraisals for Insurance, Estate Planning or Family Division purposes as well as estimates for auction.

Heffel's has the most experienced team of fine art specialists in the business, providing clients with the best opportunity for maximizing the value of their Canadian and International works.

Please visit www.heffel.com for more information, or contact one of our offices listed below.

Heffel Fine Art Auction House

Vancouver • Toronto • Ottawa • Montreal

HEFFEL GALLERY VANCOUVER
2247 Granville Street
Vancouver, BC V6H 3G1
Telephone: 604 732~6505
Toll Free: 800 528~9608

HEFFEL GALLERY TORONTO
13 Hazelton Avenue
Toronto, Ontario M5R 2E1
Telephone: 416 961~6505
Toll Free: 866 961~6505

OTTAWA OFFICE
104 Daly Avenue
Ottawa, Ontario K1N 6E7
Telephone: 613 230~6505
Toll Free: 866 747~6505

GALERIE HEFFEL MONTRÉAL
1840 rue Sherbrooke Ouest
Montréal, Québec H3H 1E4
Telephone: 514 939~6505
Toll free: 866 939~6505

Internet: www.heffel.com **E~mail: mail@heffel.com**